Baffinland

TECHNICAL SUPPORTING DOCUMENT

Mary River Project | Phase 2 Proposal | FEIS Addendum | August 2018

TSD 09

Vegetation Baseline and Impact Assessment





VEGETATION TECHNICAL SUPPORTING DOCUMENT SUMMARY

The Vegetation Technical Supporting Document provides an assessment of the Phase 2 Proposal's effects on vegetation and includes new information collected or published since submission of materials for the Approved Project. The Phase 2 Proposal builds on the extensive baseline studies and assessments carried out since 2011 for the larger Approved Project and is thus closely linked to the FEIS and previous addendums. The original concerns addressed for the Approved Project, such as Project related effects on vegetation abundance and diversity, vegetation health, and culturally valued vegetation are concerns also addressed in this Phase 2 Proposal.

In general, vegetation communities in the Project area were broadly categorized through field interpretation as uplands, coastal areas, and wetlands. The Phase 2 Proposal involves an expansion at Milne Port and the creation of the North Railway resulting in additional loss of terrestrial habitat, however, the total area affected is a small proportion of the available habitat and activities will be planned and conducted to reduce the footprint of the Phase 2 Proposal to only that which is necessary. Changes to culturally valued vegetation as a result of the Phase 2 Proposal are predicted to be negligible as the abundance of indicator species (blueberry) is very low in the area.

Fugative dust emissions can reduce plant growth and health. Fugitive dust emissions due to the transport of ore will increase temporarily along the Tote Road during construction. Once the North Railway is operational, the level of traffic on the road will decrease substantially compared to current operation and construction, as will the corresponding fugitive dust emissions along the road.

Population level changes to vegetation, and changes to the vegetation classes found in the area are not anticipated. Based on the effects assessment for the Phase 2 Proposal the current Terrestrial Environment Mitigation and Monitoring Plan does not require any updates to mitigate Phase 2 Proposal related effects.

Based on the present assessment and planned mitigation, Project activities proposed as part of the Phase 2 Proposal are not predicted to result in significant adverse residual effects on vegetation.

RÉSUMÉ DE LA DOCUMENTATION TECHNIQUE COMPLÉMENTAIRE SUR LA VÉGÉTATION

La documentation technique complémentaire sur la végétation comporte une évaluation des effets de la proposition de la phase 2 sur la végétation et comprend de nouveaux renseignements recueillis ou publiés depuis la soumission des documents pour le projet approuvé. La proposition de la phase 2 est fondée sur les études préliminaires et les évaluations complètes réalisées depuis 2011 pour l'ensemble du projet approuvé et est donc étroitement liée à l'énoncé des incidences environnementales (EIE) et aux addendas précédents. Les préoccupations initiales abordées pour le projet approuvé, telles que les impacts du projet sur l'abondance et la diversité de la végétation, la santé de la végétation et la végétation ayant une valeur culturellement, sont également abordées dans cette proposition de la phase 2.

En général, les communautés végétales de la zone du projet ont été généralement classées en fonction de l'interprétation sur le terrain en tant que hautes terres, zones côtières et zones humides. La proposition de la phase 2 comprend une expansion au port de Milne et la création du chemin de fer du Nord, entraînant ainsi une perte additionnelle d'habitat terrestre. La superficie totale touchée n'est cependant qu'une petite proportion de l'habitat disponible et des activités seront planifiées et réalisées pour réduire au minimum nécessaire l'empreinte de la proposition de la phase 2. Les changements à la végétation ayant une valeur culturelle à la suite de la proposition de la phase 2 devraient être négligeables, car l'abondance des espèces indicatrices (bleuets) est très faible dans la région.

Les émissions de poussières fugaces peuvent réduire la croissance et la santé des plantes. Les émissions de poussières diffuses dues au transport de minerai augmenteront temporairement le long de la route Tote pendant les travaux de construction. Une fois le chemin de fer du Nord opérationnel, le niveau de circulation sur la route diminuera considérablement par rapport à l'exploitation et aux travaux de construction actuels, tout comme les émissions de poussière fugitives correspondantes le long de la route.

Aucune variation des populations végétales ni aucun changement aux classes végétales de la région ne sont anticipés. D'après l'évaluation des effets de la proposition de la phase 2, le plan d'atténuation et de surveillance de l'environnement terrestre actuel ne nécessite aucune mise à jour pour atténuer les effets liés à la proposition de la phase 2.

Selon la présente évaluation et les mesures d'atténuation prévues, les activités du projet proposées dans le cadre de la proposition de la phase 2 ne devraient pas entraîner d'effets résiduels négatifs importants sur la végétation.

ᐱᕈᖅᑐᑦ ᐱᔭᕆᐊᑐᔪᒃᑯᑦ ᐃᑲᔪᐃᔾᔪᑎᑦ ᑎᑎᖅᑲᑦ ᐅᓂᒃᑳᓕᐊᑦ

ᑖᓐᓇ ᐱᕈᖅᑐᑦ ᐱᔭᕆᐊᑐᔪᒃᑯᑦ ᐃᑲᔪᐃᔾᔪᑎᑦ ᑎᑎᖅᑲᑦ ᐅᓂᒃᑳᓕᐊᖓ ᐱᑕᖃᖅᑎᑦᑎᖏᖅ ᕿᒥᕐᕈᐃᓂᕆᒃ ᑕᒪᒃᑯᓂᖓ ᐱᓕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓᒍᑕ ᐊᒃᑐᐃᓂᖃᕐᓂᖏᓂᒃ ᐱᕈᖅᑐᓂᒃ ᐊᒻᒪᓗ ᓄᑖᓂᒃ ᑐᑭᓯᐅᒪᔾᔪᑎᒃᓴᓂᒃ ᑲᑎᖅᓱᖓᑦ ᑎᑎᕋᐅᓯᐅᔪᓪᓘᓐᓃᑦ ᑕᐃᑲᓪᓚᓂᑦ ᑎᑎᕋᐅᓯᑦ ᓯᕗᓪᓕᖅᑮᑦ ᑐᓐᓂᖅᑕᐅᓚᐅᖅᑎᓪᓗᒋᑦ ᐊᖏᖅᓯᒪᔭᒧᑦ ᐅᔭᕋᓐᓂᐊᕐᓂᕐᒧᑦ. ᐱᓕᕆᐊᒃ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓ ᐃᓚᒋᐊᕆᔭᖃᖅᑐᖅ ᖃᖓᒋᒍᑦ ᐊᖏᕙᖕᖏᑦ ᑐᙵᕕᑦ ᖃᐅᔨᓴᕕᓃᑦ ᐊᕙᑖᓄᑦ ᑕᒪᓇᒎ ᕿᒥᕐᕈᐃᓂᖅ ᑕᐃᑲᖓᑦ 2011–ᒥ ᑖᓯᒎᖓ ᐃᓗᐃᑑᔪᒎᑦ ᐊᖏᖅᓯᒪᔭᒎᑦ ᐅᔭᕋᓐᓂᐊᕐᓂᕐᒎᑦ ᑕᐃᒫᒃᑐ ᐊᑕᐅᖅ ᑭᖑᓪᓕᖅᑮᑦ ᐊᕙᑎᒎᑦ ᐊᒃᑐᐃᓂᐊᕐᓂᐅᔪᑦ ᐅᓂᒃᑳᖑᓄᑦ (FEIS) ᓱᕈᓂᐊᒎᓪᓗ ᐅᐃᒍᒋᐊᖅᑕᐅᓂᑰᔪᒃᑯᑦ. ᓴᖅᑭᑕᐅᓂᑯᑦ ᐃᓱᒫᓗᑎᕙᓃᑦ ᓵᙱᔭᐅᓂᑯᑦ ᐊᖏᖅᓯᒪᔭᒎᑦ ᐅᔭᕋᓐᓂᐊᕐᓂᕐᒎᑦ, ᓱᕐᓗ ᐊᒃᑐᖅᑕᐅᔪᑦ ᐅᔭᕋᓐᓂᐊᖅᑐᓄᑦ ᐱᕈᖅᑐᑦ ᐊᒥᓱᓂᖓᓱᖏᓄᑦ ᐊᔾᔨᒋᑦᑑᑎᐅᓂᖏᓄᓪᓗ, ᖃᓄᐃᖏᓐᓂᖏᑦ, ᐃᓄᖕᓄᓪᓗ ᐊᓐᓂᖓᔭᐅᔪᑦ ᐱᕈᖅᑐᑦ ᐃᓱᒫᓗᑎᐅᕙᑦ ᑲᒪᒋᔭᐅᓯᒪᔪᑦ ᑖᕚᓂ ᐱᑕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓᒍᑦ.

ᑕᑯᔭᐃᓐᓇᖓᓪᓗᒋᑦ, ᐱᕈᖅᑐᑦ ᑲᑎᖅᓱᕐᓯᒪᓂᖏᑦ ᐅᔭᕋᕐᓂᐊᕙᐅᑉ ᓄᓇᖏᓂ ᐊᖏᕚᑦᑕᖅᑎᑕᐅᓪᓗᑎᒃ ᐊᒡᒍᖅᑕᐅᓂᒧᑦ ᓄᓇᖓ ᑕᑯᓇᒃᓗᒍ ᓲᕐᓗ ᓄᓇᑐᔪᑦ, ᓱᕝᔭᖅᐸᓱᒃᑐᑦ, ᐊᒻᒪᓗ ᒪᓴᐅᒐᔫᒃᑐᑦ ᐃᒪᖅᓱᒐᔫᒃᑐᑦ. ᐱᑕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓ ᐃᓚᕐᑲᖅᑐᑦ ᐊᖏᑕᒋᐊᕆᓂᕐᒥᒃ ᕿᙱᐊᑕ ᐅᒥᐊᕐᔪᐊᑕᕆᕝᕙᖓᒍᑦ ᓴᓇᔭᐅᓂᐊᑕᓗ ᐅᐊᖓᓃᒍᑦ ᓄᓇᓯᐅᑎᑯᑖᕐᑲᕐᕕᒃ ᐊᓯᐅᑎᑦᑎᓗᓂ ᓄᓇᒥᒃ ᐱᕈᕝᕕᐅᓯᓂᒃ ᐱᕈᖅᑐᓄᑦ ᑭᓯᐊᓂᓕ, ᓄᓇᖓ ᐊᒃᑐᖅᑕᐅᔪᖅ ᒥᑭᑑᖓᓪᓚᑦ ᐊᑐᐃᓐᓇᐅᓲᑉ ᓇᔪᓚᓇᔭᒃᓴᖏᑕ ᓄᓇᖏᓐᓂᒃ ᐱᑕᕆᓂᕗᑦ ᐸᕐᓈᕆᓯᒪᔪᑦ ᐊᑐᕐᓂᐊᖅᓗᑎᒃ ᐃᑕᖅᑯᓯᖅᑲᓐᓂᓪᒥᒃ ᒥᑭᓛᒥᒃ ᓄᓇᒥᒃ ᐊᒃᑐᐃᓇᓯᓪᓗᑎᒃ ᐊᒃᑐᖅᑕᖅ ᓴᓇᔭᐅᒪᓂᐊ 2 ᐅᒃᑑᑎᖓᓄᑦ ᐊᑐᕆᐋᖅᑲᖅᑐᑐᐊᑦ ᓄᓇᖏᓄᑦ. ᐊᓯᔾᔨᕆᓃᑦ ᐃᑕᖅᑯᓯᖅᑲᖅᑏᑦ ᐊᓐᓂᕆᔭᖏᓄᑦ ᐱᕈᖅᑐᓄᑦ ᐱᑕᕆᐋᖏᒍᑦ ᓴᓇᔭᐅᒪᓂᐊ 2 ᐅᒃᑑᑎᖓᑕ ᓂᕆᐅᒋᔭᑦ ᐃᓱᒪᒋᔭᕆᐊᖅᑲᖏᒪᕆᒃᑐᑦ ᐱᓪᓗᒍ ᐅᖅᑰᓂᖏᑦ ᐊᓐᓂᕆᔭᑦ ᐱᕈᖅᑐᖏᑕ (ᑭᒍᑕᖏᓐᓇᑦ) ᐱᕈᒐᔪᓗᐊᖏᓪᒪᑕ ᓄᓇᒋᔭᖏᒍᑦ.

ᐳᔪᕐᓗᐃᑦ ᓯᐊᒻᒪᔭᑦᑐᑦ ᒪᓂᖅᑲᒎᑦ ᓱᒃᑲᐃᑕᖅᑎᑦᑎᓲᑦ ᐱᕈᖅᑐᑦ ᐱᕈᖅᐸᓪᓚᐊᑦᑎᐊᕐᓂᖏᓐᓂᒃ ᖃᓄᐃᖏᓐᓂᖏᓐᓂᓪᓗ. ᐳᔪᕐᓗᐃᑦ ᓯᐊᒻᒪᔭᑦᑐᑦ ᒪᓂᖅᑲᒎᑦ ᐅᓯᒃᑲᖅᑕᐃᓂᖏᓄᑦ ᓴᕝᕋᔭᒃᓴᓂᒃ ᐊᖏᓕᒋᐊᕌᔫᒃᑲᔭᖅᑐᖅ ᕿᒻᒍᐊᓄᑦ ᐊᖅᑯᑖᒍᑦ ᓴᓇᔭᓕᖅᑎᓪᓗᒍ, ᑭᓱᐊᓂ ᐅᐊᖅᓈᑕ ᓄᓇᓯᐅᑎᑯᑖᕐᑲᕝᕙᖓ ᐊᐅᓚᔾᔭᒃᑯᓂ/ᐃᖏᕐᕋᓕᕈᓂ, ᐅᓄᕐᓂᖏᑦ ᐃᖏᕐᕋᔭᒃᑐᑦ ᐊᖅᑯᑎᒃᑯᑦ ᐃᓄᐃᓴᒃᓕᒋᐊᕋᔭᖅᑐᑦ ᐊᔾᔨᐅᔪᓕᐅᑎᓗᒍ ᐅᓪᓗᒥᒎᑦ ᐊᒻᒪᓗ ᐃᒡᓗᓕᐅᖅᐸᓪᓕᐊᑎᓪᓗᒋᑦ, ᒪᓕᒃᑲᔭᓇᓪᓗᓂ ᐊᒃᓴᓗᐊᓄᑦ ᐳᔪᔾᔪᓗᐊᖑᓱᖅ.

ᐱᕈᖅᑐᖃᕐᓂᖓᑕ ᐊᖏᓂᖏᑦ ᐊᓯᔾᔨᐅᑎᓃᑦ ᐱᕈᖅᑐᖏᓄᑦ, ᐊᒻᒪᓗ ᐊᓯᔾᔨᐅᑏᑦ ᐱᕈᖅᑐᓄᑦ ᐊᔾᔨᐅᔪᓐᓃᖅᑎᓇᓂᖅ ᓂᕆᐅᒋᔭᐅᖏᑦᑐᖅ ᑕᐃᑲᓂ. ᑐᙵᕕᒋᓪᓗᒋᑦ ᐊᒃᑐᐃᓂᕐᒧᑦ ᕿᒥᕐᕈᐃᓂᒃᓴᐃᑦ ᐃᓗᐊᓄᑦ ᐱᑕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓᑕ ᐅᓪᓗᒥ ᑖᓐᓇ ᓄᓇᐅᑉ ᐊᕙᑖᓄᑦ ᓱᕋᐃᓗᐊᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᐅᔾᔨᕐᓴᐃᓂᓚᒧᓪᓗ ᐸᓐᓇᐅᑎᖓ ᓄᑖᕈᓇᐊᖅᑲᖏᑦᑐᑦ ᓱᕋᐃᓗᐊᖅᑕᐃᓕᒪᓂᕐᒧᑦ ᑖᒃᑯᓂᖓ ᐱᑕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓᓄᑦ ᐊᒃᑐᐊᓂᖅᑲᖅᑐᑦ ᐊᒃᑐᐃᓂᓖᑦ ᐱᕈᖅᑐᓂᒃ.

ᑐᙵᕕᓪᓗᓂ ᐅᓪᓗᒥ ᕿᒥᕐᕈᐃᓂᐅᔪᒧᑦ ᐸᕐᓇᐅᑕᐅᔪᓄᓪᓗ ᓱᕋᐃᓗᐊᖅᑕᐃᓕᒪᓂᕐᒧᑦ, ᐅᔭᕋᓐᓂᐊᖅᑐᑦ ᐱᑕᕆᓂᖏᑦ ᐊᑐᖅᑕᐅᔪᒪᔪᑦ ᐃᓚᒋᔭᐅᔪᑦ ᑖᓯᒪ ᐱᑕᕆᐊᑉ ᒪᕐᕈᕆᓕᖅᑕᖓᓄᑦ ᐅᒃᑑᑎᖓᒍᑦ ᓇᓚᐅᑦᑖᕐᒋᒍᑦ ᓴᖅᑮᒐᔭᕐᖏᑦᑐᖅ ᐊᕐᒋᔪᒥᒃ ᐱᐅᙱᑦᑐᒥᒃ ᐱᕈᖅᑐᕐᒋᓄᑦ.

Baffinland Iron Mines Corporation
Mary River Project
Phase 2 Proposal —
Technical Supporting Document No. 09: Vegetation Baseline and Impact Assessment

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Down to Earth Biology

ENVIRONMENTAL DYNAMICS INC.

EXECUTIVE SUMMARY

The Mary River Project is an operating iron ore mine located in the Qikiqtani Region of Nunavut. Baffinland Iron Mines Corporation (Baffinland; the Proponent) is the owner and operator of the Project. As part of the regulatory approval process, Baffinland submitted a Final Environmental Impact Statement (FEIS) to the Nunavut Impact Review Board (NIRB), which presented in-depth analyses and evaluation of potential environmental and socioeconomic effects associated with the Project.

In 2012, the NIRB issued Project Certificate No 005 which provided approval for Baffinland to mine 18 million tonnes per annum (Mtpa) of iron ore, construct a railway to transport the ore south to a port at Steensby Inlet which operates year-round, and to ship the ore to market. The Project Certificate was subsequently amended to include the mining of an additional 4.2 Mtpa of ore, trucking this amount of ore by an existing road (the Tote Road) north to an existing port at Milne Inlet, and shipping the ore to market during the open water season. The total approved iron ore production was increased to 22.2 Mtpa (4.2 Mtpa transported by road to Milne Port, and 18 Mtpa transported by rail to Steensby Port). This is now considered the Approved Project. The 18 Mtpa Steensby rail project has not yet been constructed, however 4.2 Mtpa of iron ore is being transported north by road to Milne Port currently. Baffinland recently submitted a request for a second amendment to Project Certificate No.005 to allow for a short-term increase in production and transport of ore via road through Milne Port from the current 4.2 Mtpa to 6.0 Mtpa.

The Phase 2 Proposal (the third project certificate amendment request) involves increasing the quantity of ore shipped through Milne Port to 12 Mtpa, via the construction of a new railway running parallel to the existing Tote Road (called the Northern Railway). The total mine production will increase to 30 Mtpa with 12 Mtpa being transported via the North Railway to Milne Port and 18 Mtpa transported via the South Railway to Steensby Port. Construction on the North Railway is planned to begin in late 2019. Completion of construction of the North Railway is expected by 2020 with transportation of ore to Milne Port by trucks and railway ramping up as mine production increases to 12 Mtpa by 2020. Shipping from Milne Port will also increase to 12 Mtpa by 2020.

This Technical Supporting Document (TSD) provides a summary of vegetation characteristics in a Regional Study Area (RSA) surrounding the Mary River Project, highlights new information collected or new information published since submission of materials for the Approved Project. It provides a review of the issues and concerns raised in community meetings regarding effects on vegetation and updates the impact assessment on vegetation based on activities proposed for the Phase 2 Proposal.

Baseline vegetation studies were completed for the Mary River Project from 2005–2016 and included the following surveys and analyses (summaries provided Table 1):

- Vegetation Species and Communities;
- Vegetation and Soil Trace Metals;
- Revegetation Observations;
- Inuit Qaujimajatuqangit;

- Vegetation Abundance and Composition; and
- Exotic Invasive Vegetation.

The Phase 2 Proposal involves an expansion of the potential development area (PDA) at Milne Port and the addition of a new PDA for the North Railway that will result in approximately 14 km^2 of additional loss of terrestrial habitat. Fugitive dust emissions along the Tote Road will increase temporarily as Baffinland increases the road haulage of ore up to 6 Mtpa. Once the North Railway is operational, truck haulage of ore will cease and the level of traffic on the road will decrease substantially, as will the corresponding fugitive dust emissions along the road.

The original concerns addressed for the approved Project, such as Project related effects on vegetation abundance and diversity, on vegetation health, and on culturally valued vegetation are concerns also addressed in this Phase 2 Proposal. The methods used for the effects assessment of Phase 2 Proposal's activities on vegetation are consistent with the FEIS (Volume 6, Section 3.2.1).

The assessment of predicted effects on vegetation abundance and diversity is based on the identification of the amount of new disturbance that the Phase 2 Proposal will cause and the diversity of vegetation. The effects of the proposed activities on vegetation health is assessed by use of available thresholds for trace metals and emissions beyond which effects on plant health are known or suspected to occur.

A conservative approach was used in the assessment of effects on vegetation abundance and diversity by assuming that the entire PDA will be cleared during construction and operations phases. Comparison of the representation of plant communities within the RSA after removing the plant habitat within the PDA indicates that, in general, the activities associated with the Phase 2 Proposal have a similar effect as those associated with the approved Project. The additional loss of vegetation within the PDA because of the Phase 2 Proposal is considered a residual effect. Disturbed areas are not expected to become revegetated until the closure of the mine and it is assumed that some sections of the footprint will not return to baseline conditions.

For the Phase 2 Proposal, dust will be generated at Milne Inlet, Tote Road, the Mine Site, and along the North Railway. Dust associated with construction and operation of the North Railway will exceed the high threshold in 14 km^2 of terrestrial habitat outside of the PDA that was not included in the assessment of the Approved Project. An additional 94 km^2 of terrestrial habitat is exposed to high dust fall because of traffic levels on the Tote Road until ore transport shifts to the North Railway.

It is expected that Phase 2 Proposal activities will not contribute to any increase in metals in dust. It is assumed that the total predicted soil metal concentration will not change from the analysis completed for the Approved Project. The Phase 2 Proposal will not contribute to a negative effect on vegetation health because there is no predicted change to soil metal concentrations from dust.

For the Approved Project, the largest terrestrial area experiencing nitrogen dioxide emissions (outside of the PDA) is in Milne Port, followed by the Mine Site. The Phase 2 proposed activities create a 0.02 km^2 increase in the High threshold outside of the PDA at Milne Port. All vegetation classes are present in each of the areas affected by NO_2 , but no vegetation classes are disproportionally affected by NO_2 emissions outside of the PDA.

There is a moderate confidence in the predicted effects assessment on vegetation health because thresholds have not been developed for dust effects on plants, and the literature acknowledges a lack of data for effects of atmospheric emissions on Arctic vegetation. Also, potential effects of metals on plants from aerial deposition are highly dependent on site-specific conditions and the individual plant species. There is moderate confidence that the project related activities will have a not significant effect on plant health within the RSA.

Table 1. Baseline and project monitoring vegetation studies completed for the Mary River Project, 2005–2016.

Survey	Year	Purpose	Results
Vegetation Species and Communities	2005–2008	Determine what plant species and communities occur in the Project area. Confirm if any species found in the Project area are considered rare in Canada under the federal Species at Risk Act (SARA) or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).	155 vascular plant species were observed across the northern and southern portion of the Project area; this represents a relatively typical species diversity compared to other areas in the North Arctic ecozone. Vegetation communities were broadly categorized as uplands, coastal, and wetlands. No vegetation species of conservation concern were found; however, two species that had not previously been reported from northern Baffin Island were found in the northern portion of the Project area.
Vegetation and Soil Base Metals	2008; 2012–2016	Document baseline metal concentrations in vegetation and soil for the Project area.	All soil and lichen samples were below CCME and related guidelines in all sampling areas except for one soil and one lichen sample, which were suspected sampling errors. There were differences in metal concentrations between sampling areas; however, the differences are not considered biologically relevant, as all concentrations were below CCME and related guidelines.
Revegetation Observations	2005–2008; 2014	Assess the pioneer potential of native plant species in disturbed areas as candidates for revegetation.	Natural revegetation of historically disturbed areas along the old, unused sections of the Tote Road was greater in wet areas than dry areas. Native plant species may be considered good candidates for revegetation and reclamation purposes.
Inuit Qaujimajatuqangit Traditional Knowledge	2007	Determine what plant species are used by Inuit in Pond Inlet, North Baffin Island and which of these species occur in the Project area.	Inuit elders identified 20 plant species/plant groups that are traditionally used by Inuit in North Baffin Island, of which, 17 occur in the northern portion of the Project area.

Table 1. Baseline and project monitoring vegetation studies completed for the Mary River Project, 2005–2016.

Survey	Year	Purpose	Results
Vegetation Abundance and Composition	2014 and 2016	Measure percent plant cover and plant group composition of available caribou forage in the Project area to track potential changes at varying distances from the edge of the potential disturbance area (PDA).	126 vascular plant species were observed in the northern portion of the Project area. Average canopy cover by vegetation was 49.8%. Average ground cover by vegetation was 28.0%. Average percent plant cover of caribou forage across all plant groups is not different between plots at varying distances from the PDA. There are regional differences in the Project area such as harsher, drier conditions at Milne Port than the Mine Site. Incidental observations of a territorial "May Be At Risk" plant species for Nunavut were made in 2014 and 2016.
Exotic Invasive Vegetation	2014	Quantify the presence of exotic invasive plant species within and adjacent to the Project footprint.	No exotic invasive vegetation species were found during surveys of the Project footprint and adjacent areas.

ACKNOWLEDGEMENTS

Initial baseline vegetation work was performed by Page Burt from 2005–2008 accompanied by field staff from Knight Piésold, Hugo Veldhuis (soil scientist), and various Inuit field assistants. Elders from Pond Inlet who contributed to the traditional plant knowledge studies were Theresa Ootoova, Elisapee Maktar, and Ham Kadloo. Shelly Elverum and Sarahme Akumilik assisted with this work.

Additional vegetation baseline and monitoring work was conducted by EDI Environmental Dynamics Inc. and Baffinland staff from 2012–2016. Relevant staff who contributed to Project work can be referenced in the following reports:

- 2012 Annual Terrestrial Monitoring Report (EDI Environmental Dynamics Inc. 2013)
- 2013 Terrestrial Environment Annual Monitoring Report (EDI Environmental Dynamics Inc. 2014)
- 2014 Terrestrial Environment Annual Monitoring Report (EDI Environmental Dynamics Inc. 2015)
- 2015 Terrestrial Environment Annual Monitoring Report (EDI Environmental Dynamics Inc. 2016)
- 2016 Terrestrial Environment Annual Monitoring Report (EDI Environmental Dynamics Inc. 2017)

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ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
ANPC	Alberta Native Plant Council
BACI	Before-After-Control-Impact-design
Baffinland	Baffinland Iron Mines Corporation
CESCC	Canadian Endangered Species Conservation Council
CCME	Canadian Council of Ministers of the Environment
CoPC	Metals/Metalloids of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EDI	Environmental Dynamics Inc.
ERP	Early Revenue Program
FEIS	Final Environmental Impact Statement
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
IQ	Inuit Qaujimajatuqangit
KIs	Key Indicators
MDL	Minimum Detection Limit
Mtpa	Million Tonnes Per Annum
NIRB	Nunavut Impact Review Board
NLC	Northern Land Cover
PDA	Potential Development Area
SARA	Species at Risk Act
the Project	Mary River Project
TEMMP	Terrestrial Environment Management and Monitoring Plan
US EPA	US Environmental Protection Agency

1 INTRODUCTION

1.1 MARY RIVER PROJECT CURRENT OPERATIONS

The Mary River Project (Map 1) is an operating iron ore mine located in the Qikiqtani Region of Nunavut. Baffinland Iron Mines Corporation (Baffinland; the Proponent) is the owner and operator of the Project. As part of the regulatory approval process, Baffinland submitted a Final Environmental Impact Statement (FEIS) to the Nunavut Impact Review Board (NIRB), which presented in-depth analyses and evaluation of potential environmental and socioeconomic effects associated with the Project.

In 2012, the NIRB issued Project Certificate No 005 which provided approval for Baffinland to mine 18 million tonnes per annum (Mtpa) of iron ore, construct a railway to transport the ore south to a port at Steensby Inlet which operates year-round, and to ship the ore to market. The Project Certificate was subsequently amended to include the mining of an additional 4.2 Mtpa of ore, trucking this amount of ore by an existing road (the Tote Road) north to an existing port at Milne Inlet, and shipping the ore to market during the open water season. The total approved iron ore production was increased to 22.2 Mtpa (4.2 Mtpa transported by road to Milne Port, and 18 Mtpa transported by rail to Steensby Port). This is now considered the Approved Project. The 18 Mtpa Steensby rail project has not yet been constructed, however 4.2 Mtpa of iron ore is being transported north by road to Milne Port currently. Baffinland recently submitted a request for a second amendment to Project Certificate No.005 to allow for a short-term increase in production and transport of ore via road through Milne Port from the current 4.2 Mtpa to 6.0 Mtpa.

The Phase 2 Proposal (the third project certificate amendment request) involves increasing the quantity of ore shipped through Milne Port to 12 Mtpa, via the construction of a new railway running parallel to the existing Tote Road (called the Northern Railway). The total mine production will increase to 30 Mtpa with 12 Mtpa being transported via the North Railway to Milne Port and 18 Mtpa transported via the South Railway to Steensby Port. Construction on the North Railway is planned to begin in late 2019. Completion of construction of the North Railway is expected by 2020 with transportation of ore to Milne Port by trucks and railway ramping up as mine production increases to 12 Mtpa by 2020. Shipping from Milne Port will also increase to 12 Mtpa by 2020. Construction of the South Railway and Steensby Port will commence in 2021 with commissioning and a gradual increase in mine production to 30 Mtpa by 2024. Shipping of 18 Mtpa from Steensby Port will begin in 2025.

Phase 2 also involves the development of additional infrastructure at Milne Port, including a second ore dock. Shipping at Milne Port will continue to occur during the open water season and may extend into the shoulder periods when the landfast ice is not being used to support travel and harvesting by Inuit. Various upgrades and additional infrastructure will also be required at the Mine Site and along both the north and south transportation corridors to support the increase in production and construction of the two rail lines.

1.2 CHANGES FROM THE APPROVED PROJECT MATERIALS

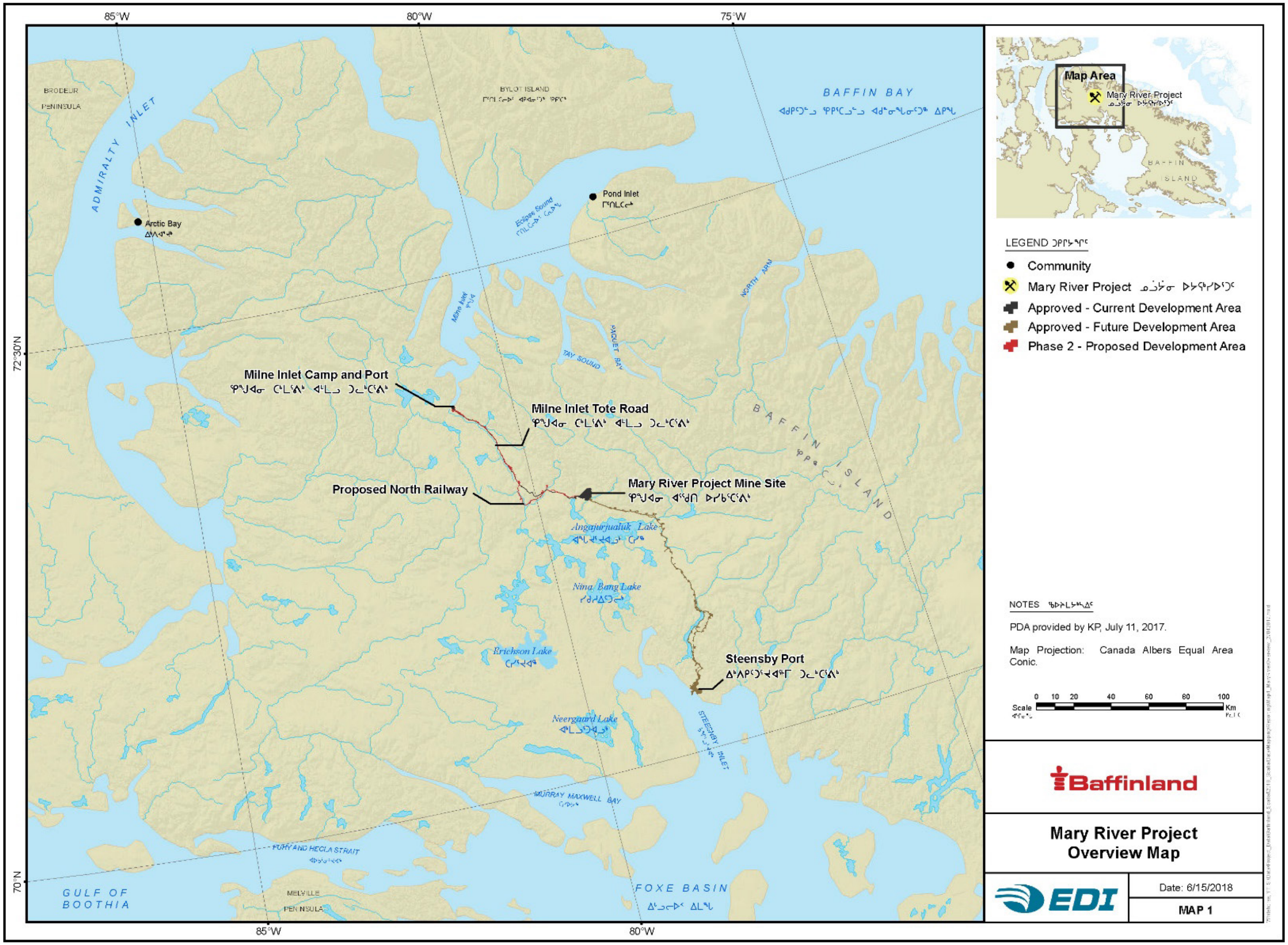
The baseline information on vegetation characteristics in this report is updated to include additional baseline and relevant monitoring data collected since 2012. This includes summaries of detailed vegetation plot data, and soils and vegetation base metals data that have been included in annual monitoring reports.

The impact assessment portion of the document addresses the potential effects on vegetation because of the increased footprint (Potential Development Area), and emissions because of the Phase 2 Proposal.

Material in this document is provided for reviewers both familiar with the Mary River Project and written materials provided since 2012, and for those that are new to the review of the Project. There should be sufficient information in this document to form a suitable understanding of the characteristics of vegetation within the immediate Project area, the Regional Study Area (RSA), and the broader north Baffin Island region. There should be sufficient information provided on the potential impacts of the Phase 2 Proposal so that reviewers can determine the characteristics of the residual impacts following proposed mitigation and inform decisions on impact significance without having to review the entire Approved Project.

1.3 REPORT OBJECTIVES

This Technical Supporting Document (TSD) provides a summary of vegetation characteristics in a Regional Study Area (RSA) surrounding the Mary River Project, highlights new information collected or new information published since submission of materials for the Approved Project for the Early Revenue Phase (ERP). It provides a review of the issues and concerns raised in community meetings regarding effects on vegetation and updates the impact assessment on vegetation based on activities proposed for the Phase 2 Proposal.


85°W
80°W
75°W
72°30'N
70°N
BRODEUR PENINSULA
ADMIRALTY INLET
BYLOT ISLAND
BAFFIN BAY
Arctic Bay
Pond Inlet
Eclipse Sound
Milne Inlet
NORTH ARM
TAY SOUND
PAQUET BAY
BAFFIN ISLAND
Milne Inlet Camp and Port
Milne Inlet Tote Road
Proposed North Railway
Mary River Project Mine Site
Angajurjualuk Lake
Nina Bang Lake
Erichson Lake
Steensby Port
Neergaard Lake
STEENSBY INLET
MURRAY MAXWELL BAY
FURY AND HECLA STRAIT
GULF OF BOOTHIA
MELVILLE PENINSULA
FOXE BASIN
Map Area
Mary River Project
LEGEND
Community
Mary River Project
Approved - Current Development Area
Approved - Future Development Area
Phase 2 - Proposed Development Area
NOTES
PDA provided by KP, July 11, 2017.
Map Projection: Canada Albers Equal Area Conic.
Scale
0 10 20 40 60 80 100
Km
Baffinland
Mary River Project
Overview Map
EDI
Date: 6/15/2018
MAP 1

2 VEGETATION CHARACTERISTICS

This section summarizes the vegetation characteristics presented in the FEIS baseline (Burt 2010) with relevant updates from the annual monitoring reports (cited where relevant in the following sections).

2.1 NORTH BAFFIN ISLAND VEGETATION ECOLOGY OVERVIEW

The Project is located on northern Baffin Island in the Northern Arctic terrestrial ecozone of Canada (Ecological Stratification Working Group 1995). An ecozone is a broad ecological unit characterized by abiotic and biotic factors. The Northern Arctic ecozone is one of the largest ecosystems in the world encompassing approximately 1.5 million square kilometres, or one seventh the size of Canada. It is often referred to as a polar desert because the climate is cold and dry with little precipitation, high winds, shallow soils, and sparsely distributed vegetation cover. Vegetation is typically stunted or low lying due to the harsh climate and there are no trees (Ecological Stratification Working Group 1995). Snow cover usually persists from September to June; therefore, the snow free period each year is approximately 60 days.

The Northern Arctic ecozone can be further described by ecological units called ecoregions which are characterized by climate, topography, vegetation, soil, water, wildlife, and land use. The Project area falls within three ecoregions (1) Borden Peninsula Plateau (2) Baffin Island Uplands and (3) Melville Peninsula Plateau. The Borden Peninsula Plateau covers a small portion in the northwestern tip of the Project area around Milne Inlet. The Baffin Island Uplands covers a small portion on the eastern edge of the Project area. Most of the Project area falls within the Melville Peninsula Plateau ecoregion which is an area of non-mountainous terrain characterized by major land components such as dry, rugged uplands, rolling plains, and lowland features with some standing water. The area is underlain by continuous permafrost and sparsely distributed vegetation cover including dwarf shrubs, forbs, grasses and sedges, mosses, and lichens.

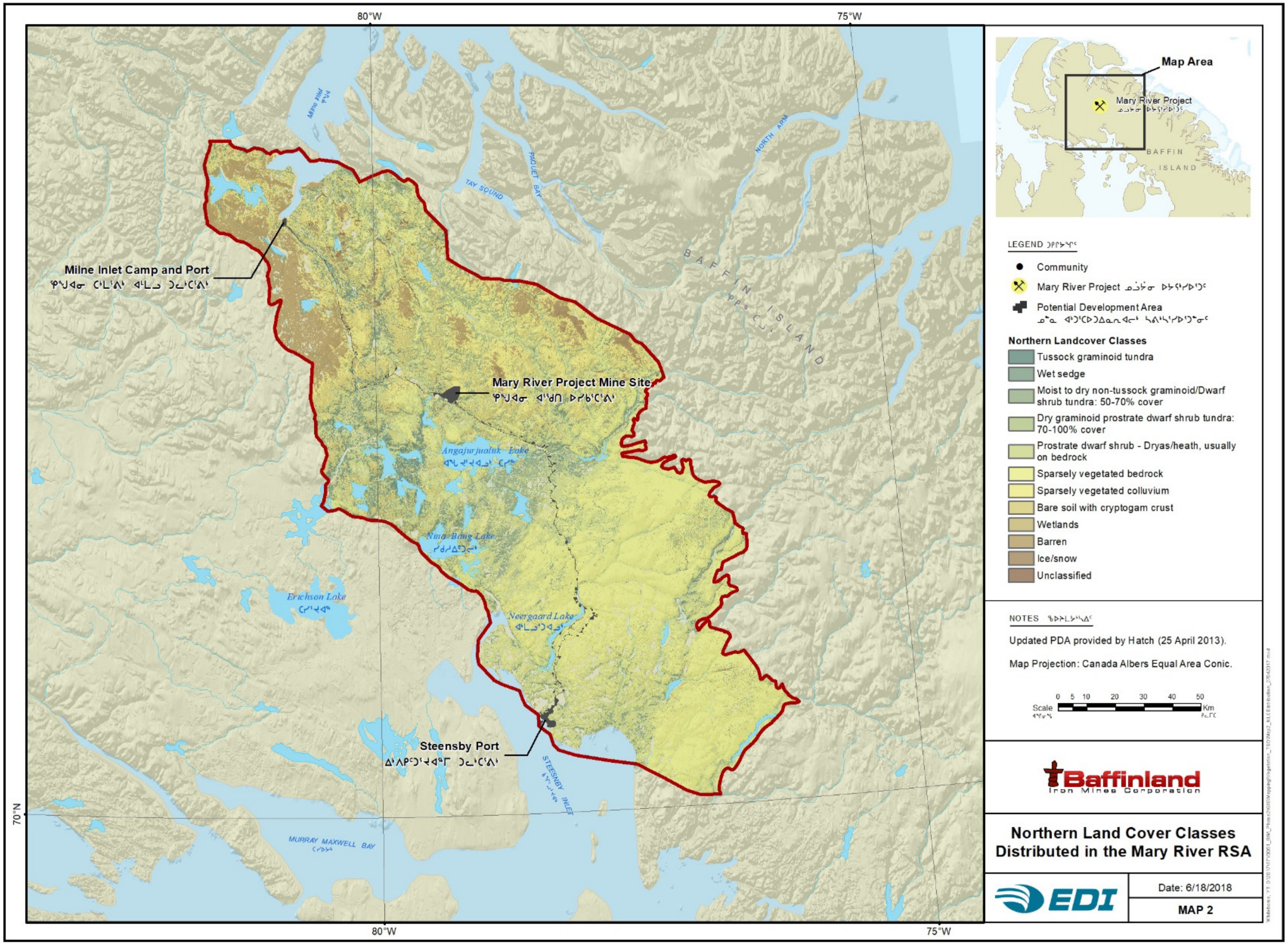
Land cover maps of northern Canada and Arctic ecosystems can be described by Northern Land Cover (NLC) classes derived from medium resolution (~30 x 30 m) satellite images (i.e., Landsat imagery; (Olthof et al. 2009). These land cover maps provide the highest level of detail available to assess vegetation cover spatially in the Arctic (Olthof et al. 2009).

There are 13 NLC classes that are recognized under five broad categories including graminoid (i.e., grasses and sedges) dominated, shrub dominated (> 25% cover), sparsely distributed vegetation (2-10% cover), wetlands, and non-vegetated (< 2% cover). The most common NLC class in the Project area is the sparsely vegetated bedrock cover type which contains 2–10% vegetation cover and generally consists of graminoids and prostrate dwarf shrubs (Appendix 6H, FEIS; Russell 2012). This indicates relatively high rock and low vegetation cover across the Project area. The second most common NLC class is the prostrate dwarf shrub cover type which typically contains > 25% vegetation cover and is made up of prostrate dwarf shrubs, graminoids, and < 10% lichen and moss (Appendix 6H, FEIS; Russell 2012). The abundance of other cover types is relatively similar, but discontinuous across the Project area. NLC classes recognized in the Mary River Regional Study Area (RSA) are included in Map 2.

2.2 REGIONAL STUDY AREA

A terrestrial Regional Study Area (RSA) was identified to ensure that the range of direct and indirect potential disturbances because of the Project's activities and region-wide vegetation characteristics could be examined and potential effects could be spatially quantified. The terrestrial RSA was chosen to represent vegetation and habitat at an ecologically relevant scale on northern Baffin Island. The terrestrial RSA also had to be a reasonable size so that surveys and information could be gathered in an economical fashion and provide information that is directly relevant to Project management and mitigation.

The terrestrial RSA is 21,054 km² and follows an approximate 50-80 km wide corridor roughly centered on the PDA (Map 2). This corridor encompasses Milne Inlet in the north, the Tote Road, and Mine Site south to Steensby Inlet. The RSA is bounded by ecological boundaries (Ecological Stratification Working Group and Schut 1995) and significant topographic and drainage features. The RSA includes variable topography from higher elevation rugged terrain in the north near Milne Inlet to low elevation rolling tundra in the south near Steensby Inlet (Appendix 6F, FEIS; EDI Environmental Dynamics Inc. 2012).


80°W
75°W
70°N
Map Area
Mary River Project
BAFFIN ISLAND
Milne Inlet Camp and Port
Mary River Project Mine Site
Steensby Port
Angajurjualuk Lake
Nina Bang Lake
Erichson Lake
Neergaard Lake
TAY SOUND
PAQUET BAY
NORTH ARM
MILNE INLET
STEENSBY INLET
MURRAY MAXWELL BAY
BAFFIN ISLAND
LEGEND
Community
Mary River Project
Potential Development Area
Northern Landcover Classes
Tussock graminoid tundra
Wet sedge
Moist to dry non-tussock graminoid/Dwarf shrub tundra: 50-70% cover
Dry graminoid prostrate dwarf shrub tundra: 70-100% cover
Prostrate dwarf shrub - Dryas/heath, usually on bedrock
Sparsely vegetated bedrock
Sparsely vegetated colluvium
Bare soil with cryptogam crust
Wetlands
Barren
Ice/snow
Unclassified
NOTES
Updated PDA provided by Hatch (25 April 2013).
Map Projection: Canada Albers Equal Area Conic.
0 5 10 20 30 40 50
Scale
Km
Baffinland
Iron Mines Corporation
Northern Land Cover Classes Distributed in the Mary River RSA
EDI
Date: 6/18/2018
MAP 2

2.3 PRE-DEVELOPMENT DATA

This section summarizes baseline vegetation work performed in the Project area from 2005–2008 prior to the submission of the FEIS (Baffinland Iron Mines Corporation 2012) and the FEIS Addendum for the Early Revenue Phase (ERP; Baffinland Iron Mines Corporation 2013). Vegetation surveys were conducted throughout the entire Project area. The focus of this section is on the northern portion of the Project area from the Mine Site to Milne Port because this is the area where Phase 2 Proposal activities are proposed. Where feasible, baseline vegetation information was used to develop existing vegetation monitoring programs. See Section 4 — Post FEIS/ERP Vegetation Work for details regarding vegetation monitoring programs.

2.3.1 KEY REFERENCE DOCUMENTS

The following report was submitted to NIRB as part of the FEIS and contains baseline vegetation information for the Project:

- Vegetation Baseline Report, FEIS Appendix 6C (Burt 2010)

2.3.2 VEGETATION SPECIES AND COMMUNITY SURVEYS

Field surveys were conducted from 2005–2008 to characterize baseline vegetation species and communities in the Project area. Surveys for rare plants were also included in baseline vegetation surveys which considered species of potential conservation concern listed under the federal *Species at Risk Act* (SARA; Government of Canada 2014*a*), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, Government of Canada 2014*b*), and from a draft list of general status ranks for vascular plants in Nunavut (CESCC 2011). A rare plant refers to a species that is rare in abundance and distribution that could be a result of low reproductive successes, preference for specialized habitat, or habitat loss from natural or human caused activities (Government of Canada 2017). Surveys for rare plants included investigations within plots, adjacent to plots, and any area of unusual habitat that was encountered while walking between sites or viewed from the helicopter.

Vegetation communities in the Project area were broadly categorized through field interpretation as uplands, coastal, and wetlands. These broad categories were further characterized into general community types (Table 2). Upland areas were dry and vegetation cover was generally patchy including shrubs, forbs, grasses, sedges, lichens, bare soil, rock, and some mosses. Wetlands were in lowland areas and were dominated by sedges, shrubs (i.e., willow species), and mosses. Coastal areas had less vegetation cover compared to the other broad vegetation categories with a strong component of rocky, gravely, and sandy shorelines and flats. Vegetation generally consisted of forbs, grasses, and sedges.

Vegetation plots measuring 5 x 5 m were selected on the ground within a single plant community. Within each plot, all plant species observed and general community type were recorded.

Visual estimates of percent plant cover by species were documented inside the plots. A total of 760 plots were surveyed and 155 vascular plant species were observed across both the northern and southern portion of the Project area. Vegetation species diversity in the Arctic is generally low with an average of approximately 150 species (Ecological Stratification Working Group 1995). This indicates that the Project area has relatively typical species diversity for an Arctic ecosystem. In comparison, Bylot Island in Sirmilik National Park has documented at least 147 vascular species (Parks Canada 2004). Common species seen in the Project area included purple saxifrage (*Saxifraga oppositifolia*), mountain avens (*Dryas integrifolia*), arctic heather (*Cassiope tetragona*), arctic willow (*Salix arctica*), lousewort (*Pedicularis* spp.), and sedges (*Carex* spp.). For a complete list of all species observed during baseline vegetation surveys from 2005–2008, refer to Appendix F of the FEIS Vegetation Baseline Report (Burt 2010).

No vegetation species of conservation concern were encountered during baseline vegetation surveys; however, two species that had not previously been reported from northern Baffin Island were found in the northern portion of the Project area. Yellow mountain saxifrage (*Saxifraga aizoides*) was found growing on rocky, frost-scarred terrain along the Tote Road. It was considered common across the landscape where it was found. This finding represents a large and impressive range extension for this species, not previously known in northern Baffin Island. Creeping sedge (*Carex chordorrhiza*) was found growing in a wet area along the Tote Road. This sedge was uncommon in the Project area and represents a range extension for northern Baffin Island.

Table 2. Baseline vegetation community types encountered in the Project area, 2005–2008.

Broad Category	Community Type
Wetlands	Sedge community
	Moss community
	Willow community
Uplands	Heath tundra community
	Lichen-rock community
	Barrens
	Snowbank association
	Miscellaneous
Coastal	Rocky, gravel, sandy shorelines and flats

2.3.3 VEGETATION AND SOILS TRACE METALS

Vegetation and soil samples were collected in the Project area during the summer of 2008 to characterize baseline metals/metalloids (referred to as metals hereafter) in vegetation and soil. Collections mainly focused on the southern portion of the Project area; in the northern portion, relatively few sites were sampled. Sampling sites were located adjacent to vegetation plots where vegetation species and communities were characterized (see Section 3.2 — Vegetation Species and Communities Surveys).

Sites were located close to the edge of the Potential Development Area (PDA) where the potential for dust and emissions uptake by vegetation was identified. Soil and vegetation samples were collected outside of the vegetation plot where species and communities were characterized. Methods provided in the baseline vegetation report were limited. Soil samples were collected "close to the surface" and vegetation included a mixture of available species. In total, 13 vegetation species were collected across ten sample sites, all generally in the proximity of the mine site (Table 3; locations shown in Figure 6 in Burt 2010). Vegetation and soil samples were analyzed for a suite of metals (Table 4). Results of the metals analysis are provided in Appendix H of the FEIS Vegetation Baseline Report (Burt 2010).

Table 3. Vegetation and soil base metals sampling sites and species, northern portion of the Project area, 2008.

Site	Vegetation Species
08-VP22	Arctic willow Sedge #1
08-VP23	Arctic willow Mountain avens Sedge #4
08-VP24	White arctic heather
08-VP25	Arctic willow Multiple-flowered cottongrass, Richardson's willow
08-VP26	Blueberry Grey cushion moss Sedge #2
08-VP27	Arctic willow Mountain avens Grey cushion moss
08-VP28	Grey cushion moss Yellow crazyweed White arctic heather
08-VP31	Arctic willow Alpine foxtail Grey cushion moss
08-VP32	Arctic willow Multiple-flowered cottongrass
08-VP33	Arctic willow Mountain avens Sedge #3
Total of 10 Sites	**Total of 13 Species**

Table 4. Metals included in the analysis of vegetation and soil samples, 2008.

Metal	
aluminum (Al)	mercury (Hg)
arsenic (As)	molybdenum (Mo)
barium (Ba)	nickel (Ni)
beryllium (Be)	potassium (K)
bismuth (Bi)	selenium (Se)
boron (B)	silver (Ag)
cadmium (Cd)	sodium (Na)
calcium (Ca)	strontium (Sr)
chromium (Cr)	sulfur (S)
cobalt (Co)	thallium (Tl)
copper (Cu)	tin (Sn)
iron (Fe)	titanium (Ti)
lead (Pb)	uranium (U)[1]
magnesium (Mg)	vanadium (V)
manganese (Mn)	zinc (Zn)

[1] Vegetation sample analysis in 2008 did not include uranium

2.3.4 REVEGETATION OBSERVATIONS

Observations of natural revegetation were made during baseline vegetation surveys 2005–2008 at disturbed sites where vegetation cover had been previously removed due to natural or human caused activities. Causes of natural disturbance included geological processes (frost heaving, landslides, slumps) and animal activities (den sites, bird nests, wildlife trails). Human caused disturbances included old road systems, airstrips, Inuit camps and caches, and sampling sites. In the northern portion of the Project area a total of 20 locations were surveyed along or adjacent the old Tote Road. Notable observations of natural revegetation are summarized below:

- Revegetation had occurred along the old Tote Road, particularly in wet areas.
- Revegetation appeared to be slower to almost immeasurable at dry sites along the old Tote Road and previously established Inuit camps.
- Previously disturbed sites near Sheardown Lake appeared lush and had a high number of species and overall abundance than was expected.
- Generally, local species appear to be recolonizing disturbed sites and may be considered good candidates for revegetation and reclamation purposes.

2.3.5 INUIT QAUJIMAJATUQANGIT TRADITIONAL KNOWLEDGE

Vegetation baseline surveys incorporated traditional plant use studies in the summer of 2007 in consultation with elders in Pond Inlet. Three elders with knowledge in traditional plant use participated in the study including Elisapee Ootoova, Theresa Mucktar, and Ham Kadloo. A botanist (Page Burt) and anthropologist (Shelly Elverum) led the study with assistance by Sarahme Akoomalik as an interpreter.

The study included interviews and field trips with elders to discuss plants of traditional use. Twenty plant species/plant groups were identified around Pond Inlet and the traditional uses of the plants were documented, of which 17 species are known to occur in the northern portion of the Project area. For a complete list of all plants included in the traditional knowledge study see Appendix G in the Vegetation Baseline Report, Appendix 6C, FEIS (Burt 2010).

Traditionally, plants were used for food, tea, fire starter, and medicinal purposes. Leaves were used to make tea from plants such as blueberry (*Vaccinium uliginosum*), purple mountain saxifrage (*Saxifraga oppositifolia*), prickly saxifrage (*Saxifraga tricuspidata*), and large-flowered wintergreen (*Pyrola grandiflora*). The leaves of willow (*Salix arctica*), bistort (*Bistorta vivipara*), woolly lousewort (*Pedicularis lanata*), and mountain sorrel (*Oxyria digyna*) were consumed as trail snacks. The roots of yellow crazyweed (*Oxytropis maydelliana*) were eaten for sustenance. Where available, berries were also consumed, including blueberry and crowberry (black berry; *Empetrum nigrum*). The silky white heads of arctic cotton (*Eriophorum* spp.) and willow "fluff" were used as candle wicks or to cover a bleeding wound.

Traditional plant use was mainly opportunistic and occurred during travel and when hunting. Traditional plant use such as berry picking and plucking leaves as a trail snack or for tea still occurs as part of culture on northern Baffin Island.

2.4 PROJECT MONITORING DATA

This section summarizes vegetation monitoring work conducted 2012–2016 in the Project area. All vegetation monitoring programs to date have been implemented within the northern portion of the Project area currently being used by Baffinland from the Mine Site to Milne Port. Vegetation monitoring programs were initiated to address approved Project Conditions and further characterize vegetation in the Project area. Where feasible, baseline vegetation work conducted from 2005–2008 was used to develop existing vegetation monitoring programs. Vegetation information provided in this section are used as a supplement to the pre-development data to characterize baseline conditions for Phase 2 Proposal.

2.4.1 KEY REFERENCE DOCUMENTS

The following reports provide the results of vegetation monitoring programs completed for the Project:

- 2012 Annual Terrestrial Monitoring Report
(EDI Environmental Dynamics Inc. 2013)
- 2013 Terrestrial Environment Annual Monitoring Report
(EDI Environmental Dynamics Inc. 2014)
- 2014 Terrestrial Environment Annual Monitoring Report
(EDI Environmental Dynamics Inc. 2015)
- 2015 Terrestrial Environment Annual Monitoring Report
(EDI Environmental Dynamics Inc. 2016)
- 2016 Terrestrial Environment Annual Monitoring Report
(EDI Environmental Dynamics Inc. 2017)
- Terrestrial Environment Management and Monitoring Plan (TEMMP), Rev 3.3
(Baffinland Iron Mines Corporation 2016*a*)

These monitoring reports also address Project Conditions relevant to vegetation included in the NIRB Project Certificate No. 005.

2.4.2 VEGETATION ABUNDANCE AND DIVERSITY

To address Project Conditions for the NIRB Project Certificate No. 005, Baffinland established a long-term monitoring program to study potential changes to vegetation used as caribou forage in the Project area. Data collected as part of the vegetation monitoring program provides additional baseline information, such as vegetation abundance and composition, for the northern portion of the Project area.

2.4.2.1 Survey Methods

Baseline vegetation data was collected in 2014 and 2016 as part of the vegetation abundance monitoring program. This program was based on a Before-After-Control-Impact-design (BACI; Bernstein and Zalinski 1983, Stewart-Oaten et al. 1992) with a stratified random paired/block design. The BACI design is common for impact assessments where the goal is to determine whether there is a statistically significant and biologically meaningful difference between baseline and disturbance conditions (e.g., changes to abundance of a species). This design involves pairing control and impacted sites where samples are taken simultaneously at both sites before and after a disturbance occurs.

Sample sites were stratified by habitat type (using Northern Land Cover LandSat imagery; see Section 2.1.2 — Northern Land Cover of the Regional Assessment Area). To reduce natural variability in vegetation cover associated with differing habitat types and to allow for meaningful statistical comparisons, all sites were located within one habitat type.

The habitat type chosen was based on:

- Relative abundance of habitat type (as summarized in the FEIS Wildlife Baseline Report; EDI 2012);
- Relative habitat use by caribou (a mixture of the Resource Selection Probability Function model results in the FEIS Wildlife Baseline Report and the energetics model presented in Russell (2014); and
- Likelihood of habitat type containing high quality caribou forage (FEIS Wildlife Baseline Report; EDI 2012).

The habitat type selected for vegetation abundance monitoring was the Moist to Dry Non-Tussock Graminoid/Dwarf Shrub type, one of the more common habitats in the RSA (Photo 1). The North Baffin Caribou herd does not appear to select one habitat type over another, but do exclude areas where vegetation cover is relatively low (Russell 2014). The Moist to Dry Non-Tussock Graminoid/Dwarf Shrub vegetation habitat type is considered high quality caribou forage, given that it contains lichen, grasses, sedges, forbs, and deciduous shrubs. These plant groups are considered important food items for caribou in summer when plant nutritional value and digestibility is high, as well as in winter when food availability is mainly limited to lichen.

The vegetation abundance monitoring program includes 15 transects radiating out from the Mine Site (six transects), Tote Road (five transects), and Milne Port (four transects). In addition, six control (reference) sites were established within the Project area, approximately 20 km from the Project footprint. Each transect is situated perpendicular to the Project footprint. Along each transect, sample sites were located at 30 m, 100 m, 750 m and 1,200 m from the PDA (Figure 1). In total, 66 sample sites were located within the Project area (Map 3).

To remove potentially confounding effects of grazing (e.g., from caribou and small mammals) enclosure (i.e., closed plots) and open plots were used to account for effects from herbivory. At the time of plot establishment none of the sites selected for this study showed signs of herbivory. Each sample site consisted of one closed plot and one open plot. Vegetation was measured in 1 x 1 m plots (both open and closed). At closed plots, 2 x 2 m cages were installed on top of the 1 x 1 m plots to prevent potential herbivory and to prevent edge effects between the measuring plot and the cage. To account for within-site variability in vegetation cover, some sites included a second open plot, for a total of three plots at one site. In total, 151 plots were sampled. A typical site illustrating plot lay-out, topography, vegetation characteristics, and closed plot cage construction is illustrated in Photo 2. A table of all plots, transects, distances, treatments, and coordinates is provided in Attachment 1 — Vegetation Abundance Monitoring Site Locations.

Vegetation was measured for percent plant cover by plant group and plant group composition using the point quadrat method. The point quadrat method is considered one of the most objective and repeatable methods for monitoring vegetation (Levy and Madden 1933, Goodall 1952, Bonham 2013) and is the recommended method for assessing vegetation changes in tundra plant communities (Molau and Mølgaard 1996). It is a quantitative method that has been widely recommended for long-term monitoring of vegetation abundance (Stampfli 1991, Elzinga et al. 1998, Hudson and Ouimet 2011).

The point quadrat method involves a square 1 x 1 m metal plot frame with 100 fixed sampling points spaced 10 cm apart (Figure 2; Photo 3). There was a total of 200 sampling points per plot: 100 measurements across the canopy cover layer and the same across the ground cover layer. At each sampling point a laser beam was projection downward onto the vegetation and the first plant species that was touched or "hit" by the laser in the canopy layer and in the ground layer were tallied (Figure 3). Percent plant cover was determined by summing the total number of "hits" for each plant group in each of the canopy and ground layers. The plant groups selected for this study were based on those used in the caribou energetics model (Russell 2014) and included:

- Deciduous shrubs
- Evergreen shrubs
- Forbs
- Graminoids (grasses and sedges)
- Lichen
- Moss
- Standing dead litter

Standing dead litter was included as important winter forage that is digested more than expected and provide nutritional balance to caribou winter diet (Heggberget et al. 2002). Dead ground litter, un-vegetated substrates including bare ground, rock, or gravel and cryptobiotic soil crusts were recorded but excluded from the percent cover values because these do not represent useable forage for caribou.

2.4.2.2 Data Analysis

Data analyzed as part of the vegetation abundance monitoring program provides baseline information in addition to initial baseline vegetation surveys. Specifically, the vegetation abundance monitoring program assessed: 1) total percent ground cover, 2) total percent canopy cover, and 3) percent cover by plant group for all monitoring plots established in 2014 and 2016 in the northern portion of the Project area.

The percent plant cover of each plant group was first quantified by adding up all the "hits" from the laser for a plant group within a plot. This was done separately for the ground cover and canopy cover layers. The total number of "hits" within a plot represented overall percent plant cover.

Data were then analyzed to assess: 1) differences in total ground cover and total canopy cover relative to distance from the PDA or plot treatment (i.e. closed vs. open plots) and 2) differences in plant group composition relative to focal area (Mine Site, Tote Road, or Milne Port), distance from PDA, or plot treatment. Analysis was done separately for ground cover and canopy cover. All estimates are reported as average plant cover with 95% confidence intervals. Because baseline sampling occurred over two years, results represent average plant cover for all baseline sampling (2014 and 2016). Analyses were performed using R, version 3.3.1 (R Core Team 2014).

Photo 1. Example of the Moist to Dry Non-Tussock Graminoid/Dwarf Shrub vegetation habitat type in the Project area selected for the vegetation abundance monitoring program.

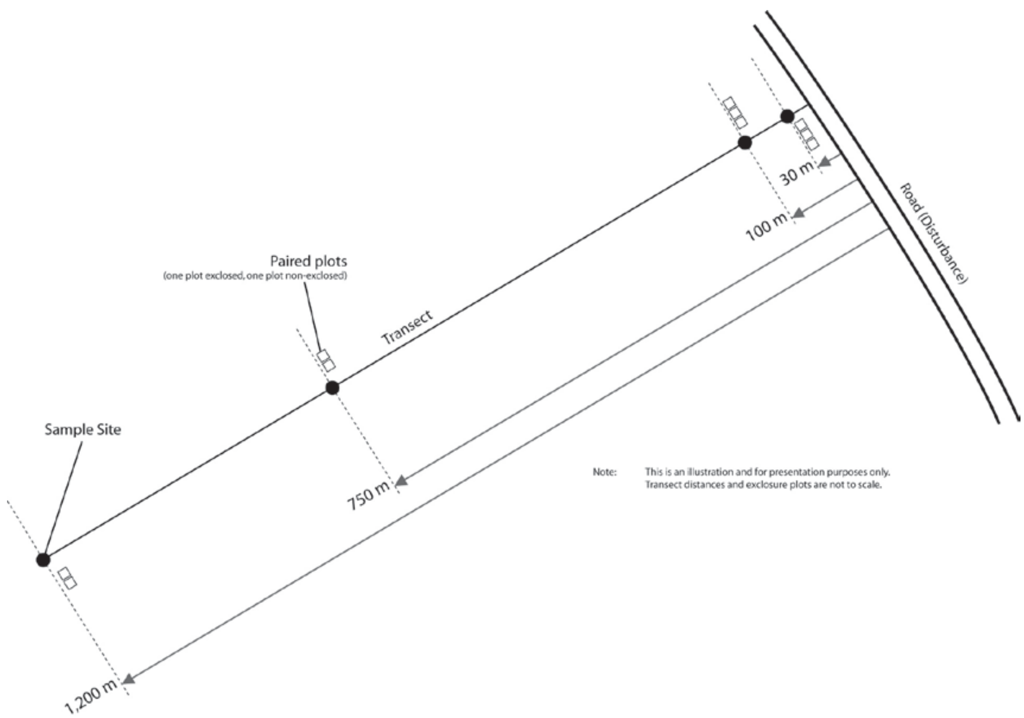
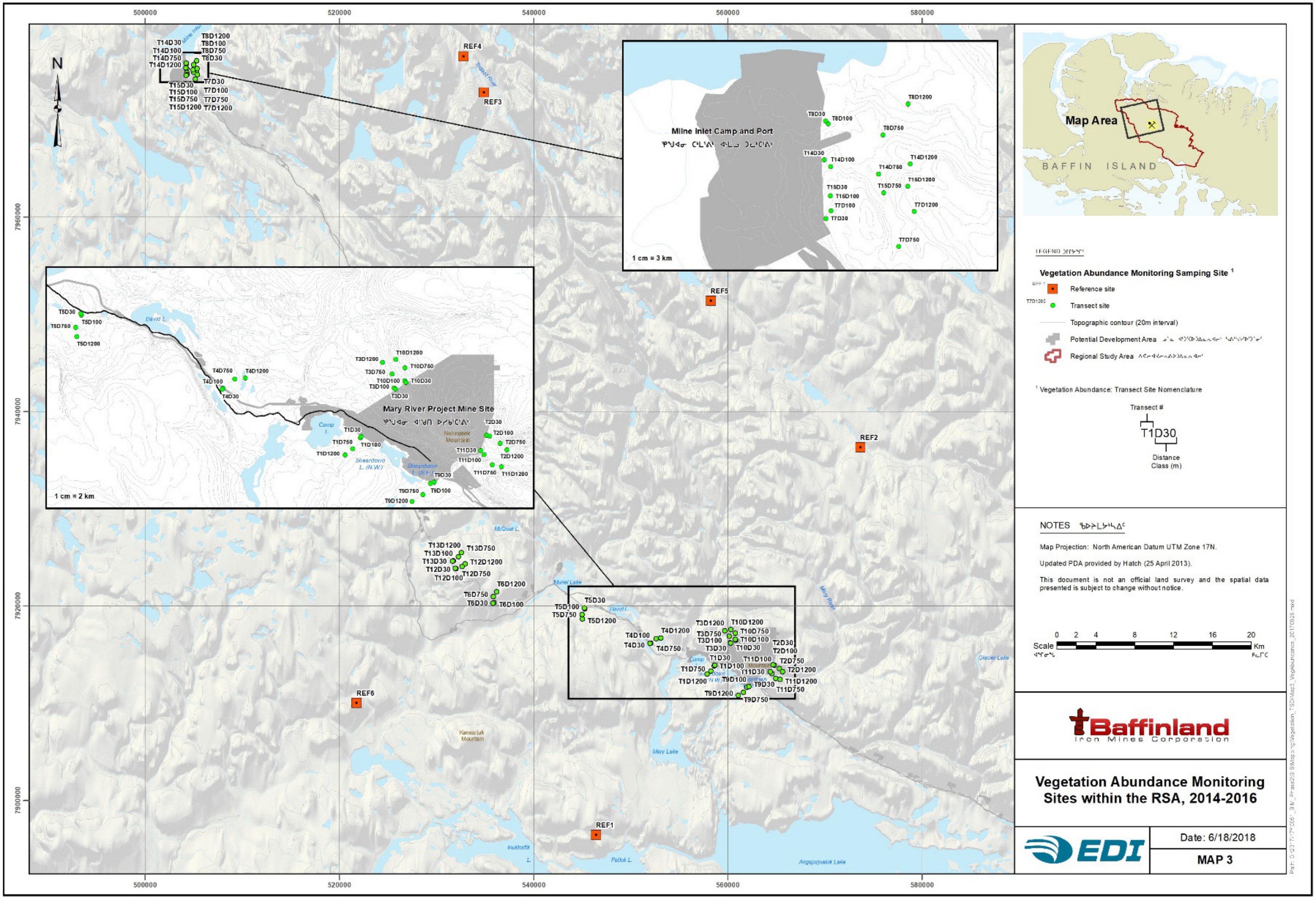


Figure 1. Schematic diagram showing the location of sample sites and plots along a transect.


Vegetation Abundance Monitoring Sites within the RSA, 2014-2016
Mary River Project Mine Site
Milne Inlet Camp and Port
Map Area
BAFFIN ISLAND
LEGEND
Vegetation Abundance Monitoring Samping Site
Reference site
Transect site
Topographic contour (20m interval)
Potential Development Area
Regional Study Area
Vegetation Abundance: Transect Site Nomenclature
Transect #
T1D30
Distance Class (m)
NOTES
Map Projection: North American Datum UTM Zone 17N.
Updated PDA provided by Hatch (25 April 2013).
This document is not an official land survey and the spatial data presented is subject to change without notice.
Scale
Km
Baffinland
Iron Mines Corporation
EDI
Date: 6/18/2018
MAP 3
1 cm = 3 km
1 cm = 2 km
REF1
REF2
REF3
REF4
REF5
REF6

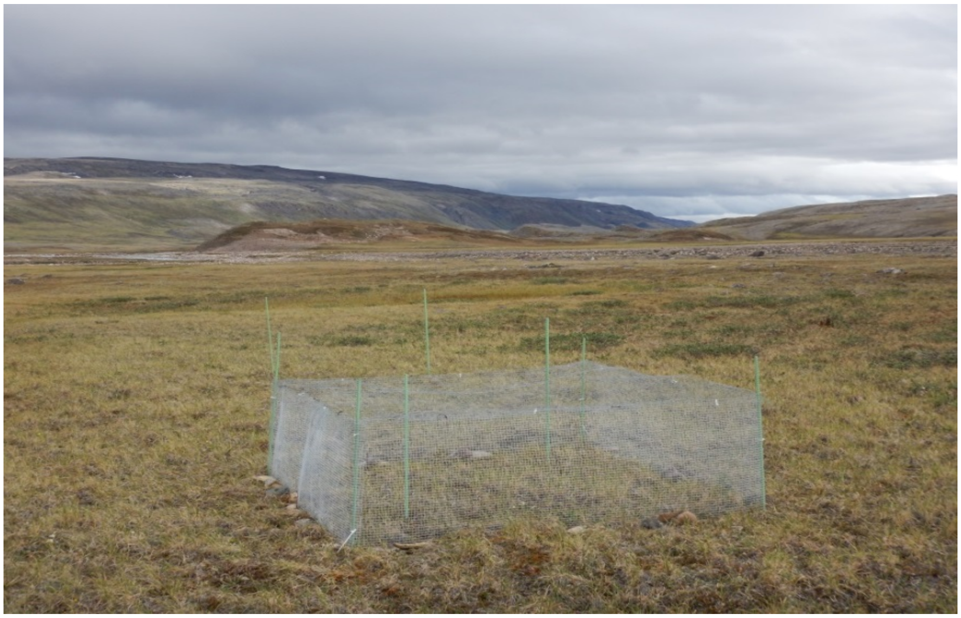


Photo 2. Representative site photo of general plot lay-out and site conditions.
Site T9D100 with one closed plot and one open plot located south of the emulsion building near the Mine Site, 25 July 2016.

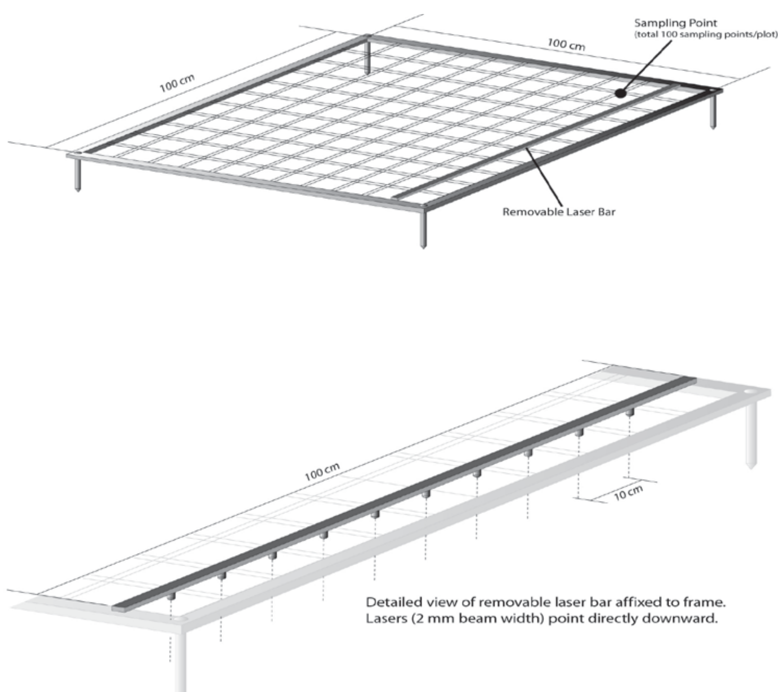


Figure 2. Illustration of the point quadrat frame used to measure percent plant cover.

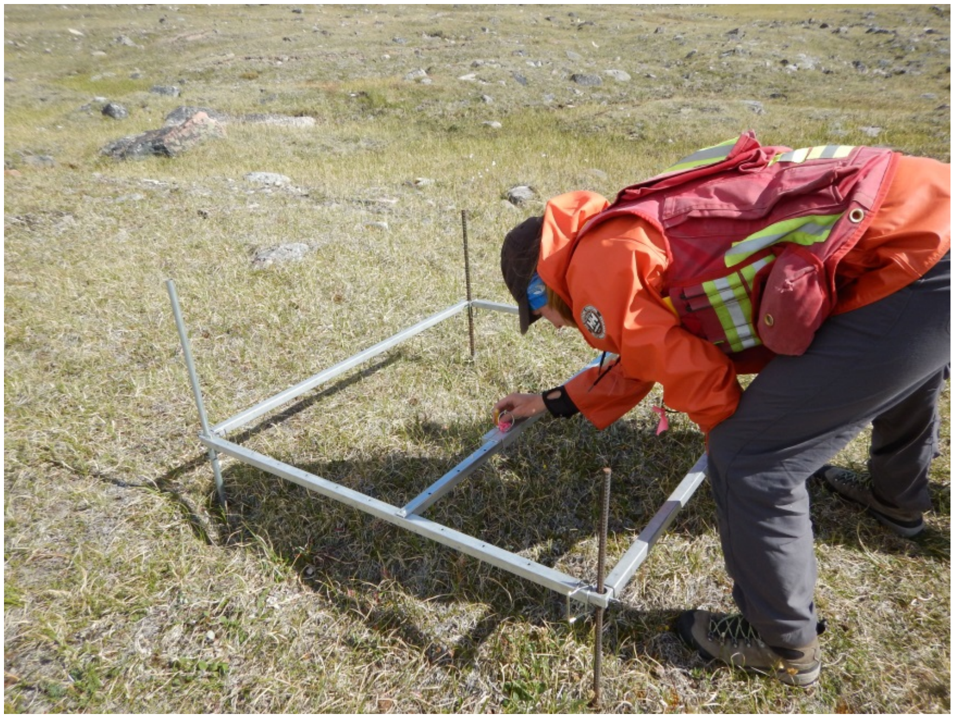


Photo 3. Measuring plot frame erected above the vegetation during sampling, 22 July 2016.

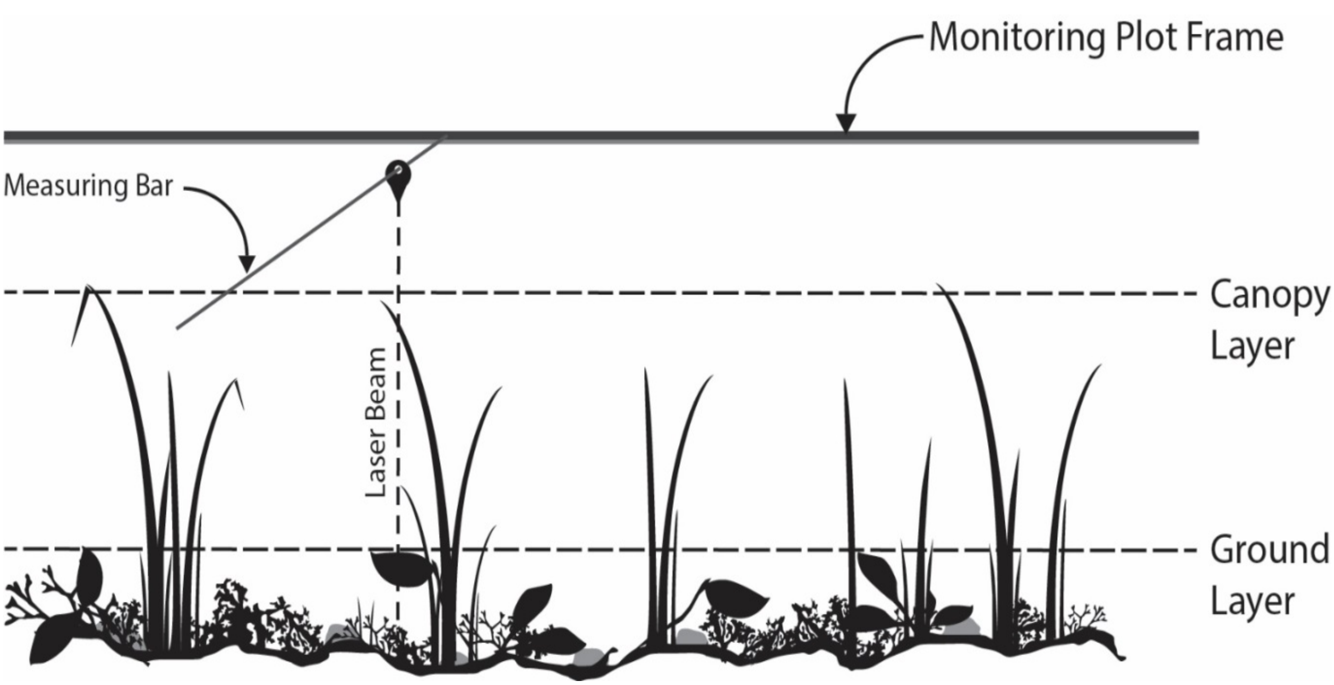


Figure 3. Schematic diagram of canopy and ground cover.

Showing the laser beam of the monitoring plot frame "hitting" the first plant in the canopy layer and then the first plant in the ground layer.

2.4.2.3 Results and Discussion

A total of 126 vascular plant species were observed in the northern portion of the Project area during 2014 and 2016 vegetation abundance monitoring. Combined, all baseline vegetation surveys 2005-2016 recorded 184 vegetation species (and associated subspecies), including vascular and non-vascular plants. This does not contain all non-vascular species (lichens and mosses) for northern Baffin Island; instead, only those that could be identified confidently were included. For a complete list of all species observed and updated 2005–2016 baseline vegetation species list, refer to Attachment 2 — Updated Baseline Vegetation Species List (2005–2016).

The vegetation abundance monitoring program focused on the Moist to Dry Non-Tussock Graminoid/Dwarf Shrub vegetation habitat type that contained a mixture of grasses, sedges, shrubs, forbs, lichen, and mosses. Generally, vegetation cover was sparsely distributed with a high proportion of rock or bare ground. Sites towards Milne Port showed some differences in ground cover ($p<0.001$; Figure 4) and canopy cover ($p = 0.01$; Figure 5) that indicate regional differences in the Project area such as harsher, drier conditions at Milne Port than the Mine Site. This is expected given that the study area is large and the comparison of sites across this range is more variable than within a given focal area.

Across all monitoring plots, average ground cover by vegetation was 28.0%. There was no evidence of a difference in ground cover by distance class ($p = 0.72$) or plot treatment (open vs. closed; $p = 0.53$). There was also no support for an interaction between distance class and plot treatment ($p = 0.17$; Figure 6). Moss was the highest ground cover (8.5%; CI = 7.1 – 10.1), followed by evergreen shrubs (4.3%; CI = 3.5 – 5.2), and lichens (1.8%; CI = 1.5 – 2.3; Figure 7).

Average canopy cover was 49.8%. There was no evidence of a difference in canopy cover by distance class ($p = 0.38$). There was no support for an interaction between distance class and plot treatment ($p = 0.13$; Figure 8). Standing dead litter was the highest canopy cover (25.3%; CI = 23.3 - 27.4), followed by graminoids (10.5%; CI = 9.5 – 11.6), deciduous shrubs (4.5%; CI = 4.0 – 5.1), evergreen shrubs (3.8%; CI = 3.3 – 4.3), and forbs (2.2%; CI = 9.5 – 11.6; Figure 9).

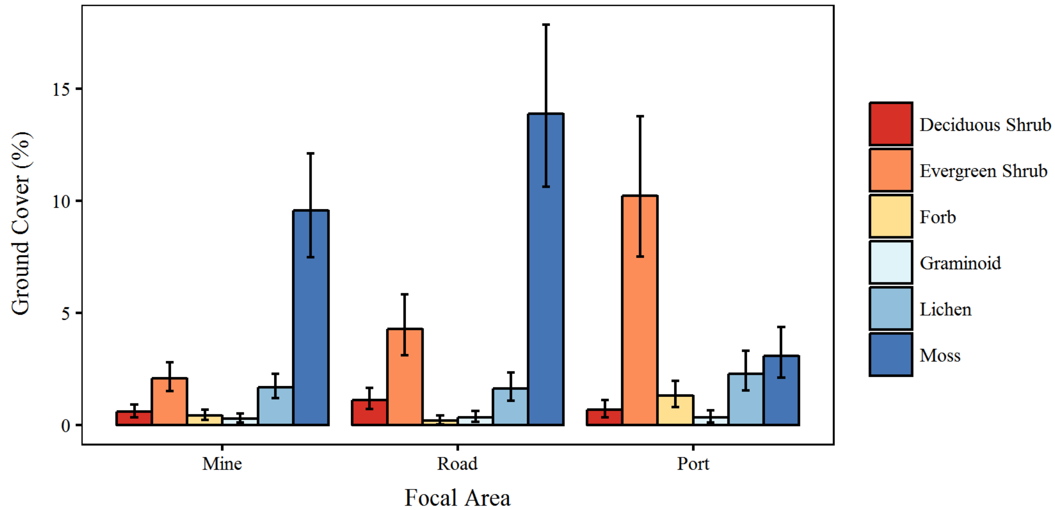


Figure 4. Average ground cover for each of the plant groups within the three focal areas.
Bar heights show average canopy cover and error bars show 95% confidence intervals.

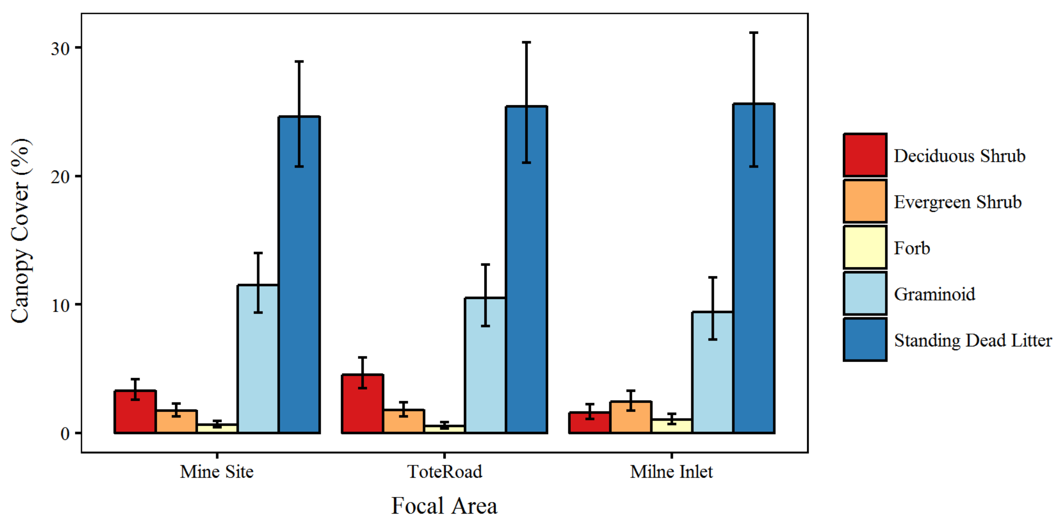


Figure 5. Average canopy cover for each of the plant groups within the three focal areas.
Bar heights show average canopy cover and error bars show 95% confidence intervals.

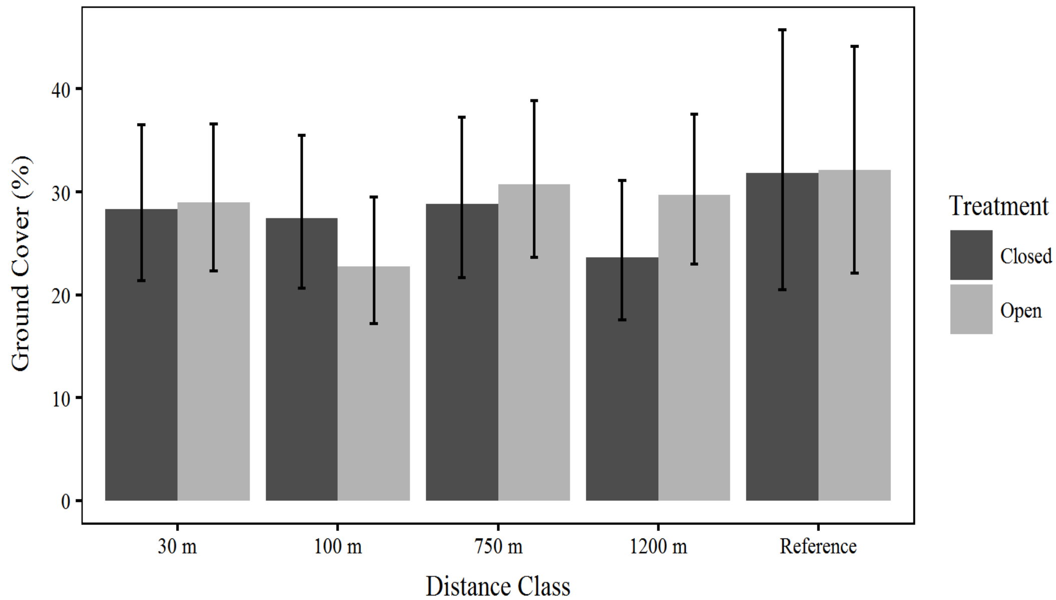


Figure 6. Average ground cover by distance class and plot treatment.
Bar heights show average canopy cover and error bars show 95% confidence intervals.

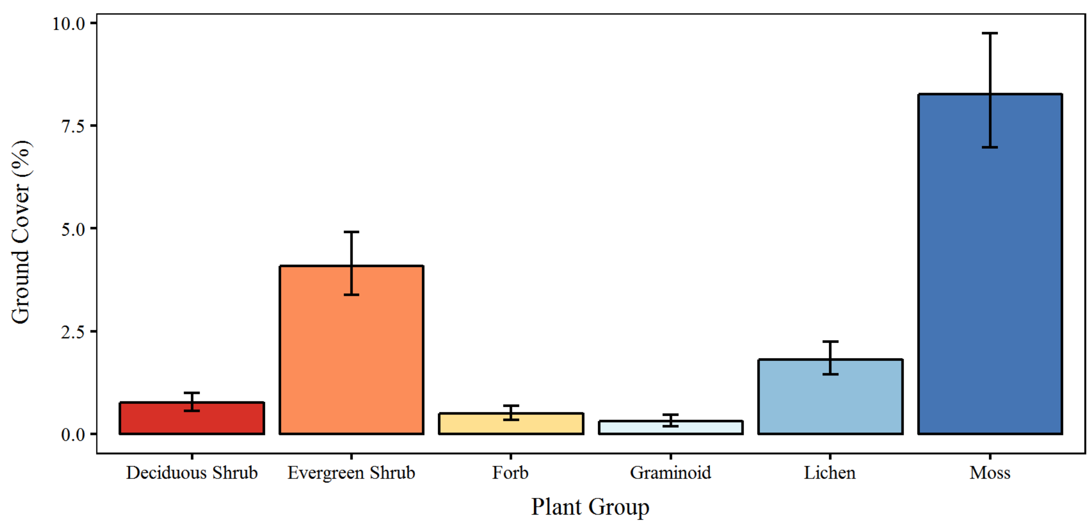


Figure 7. Average ground cover for each of the plant groups.
Bar heights show average canopy cover and error bars show 95% confidence intervals.

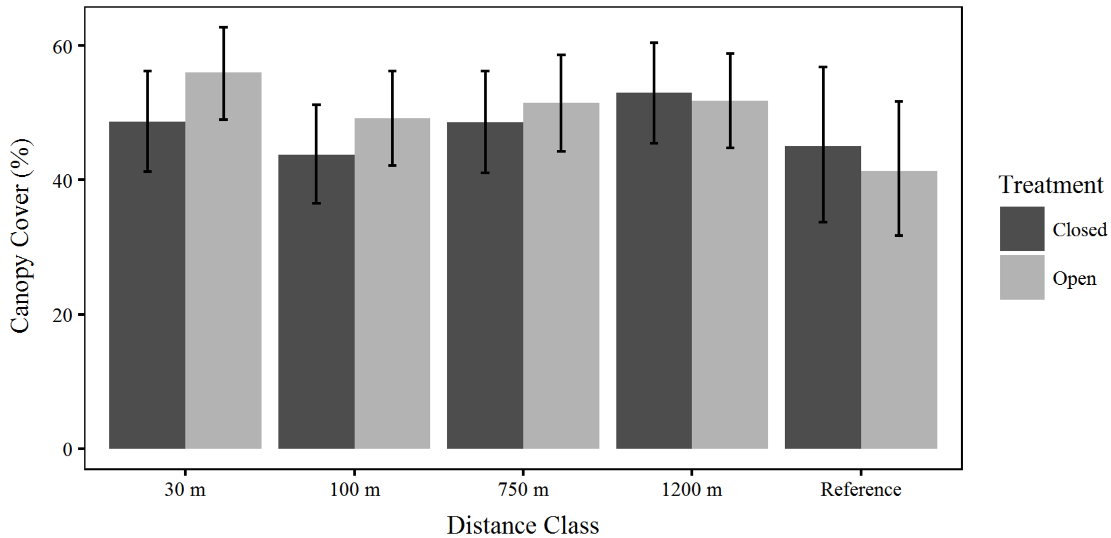


Figure 8. Average canopy cover by distance class and plot treatment.
Bar heights show average canopy cover and error bars show 95% confidence intervals.

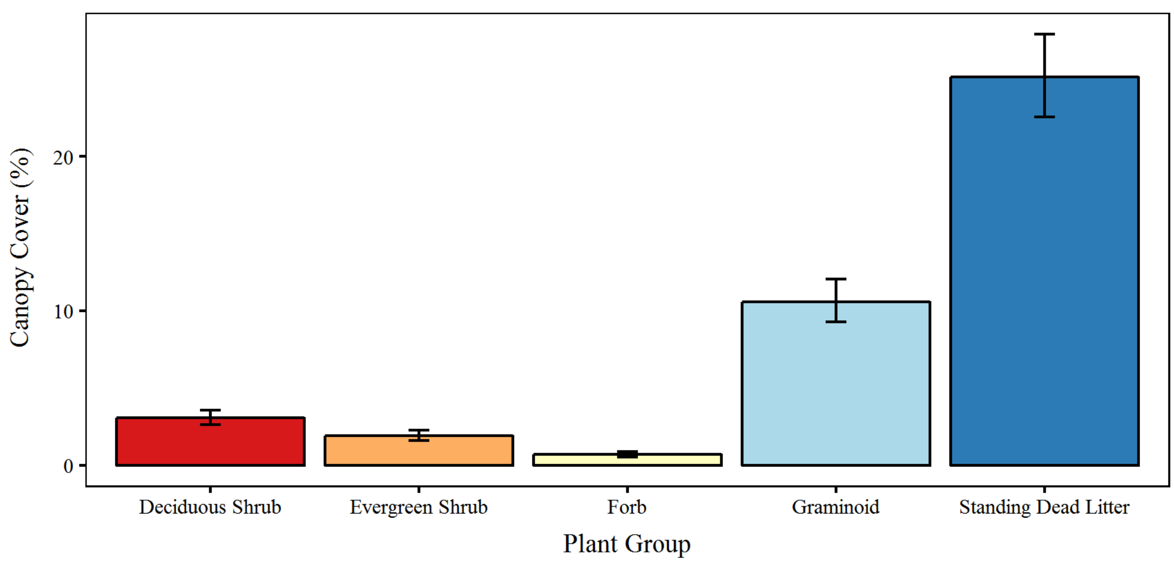


Figure 9. Average canopy cover for each of the plant groups.
Bar heights show average canopy cover and error bars show 95% confidence intervals.

During field surveys, incidental observations of a territorial "May Be At Risk" species for Nunavut were made in 2014 and 2016. Horned dandelion (*Taraxacum ceratophorum*) is a native dandelion species in Nunavut (Photo 4; Canadian Endangered Species Conservation Council (CESCC) 2011). This species was not previously reported in northern Baffin Island and this finding represents a large range extension for northern Baffin Island and significant contribution to the overall knowledge of the species (Brouillet 2014). Horned Dandelion was found near the Mine Site and along the Tote Road from km 84.6 to 85.2. Where Horned Dandelion was found, the habitat was open and dominated by sand. All plants were in flower and appeared healthy. Near the Mine Site, two populations with 31 individuals were found. Along the Tote Road, approximately 750–800 individuals within five sub-populations were found growing within 50 m of the road. See Table 5 for location details of horned dandelion occurrences within the Project area.

Table 5. Location details for Horned Dandelion, a "May Be At Risk" species found incidentally during vegetation surveys in 2014 and 2016.

Year	Location Description	Habitat	Latitude	Longitude	Abundance and Distribution
2014	Edge of PDA near KM 93.5, along Tote Road, sea can storage area	Sandy, exposed slope and small drainage leading down to delta	71.32708	-79.45897	25 scattered flowering plants in close vicinity
2014	Near KM 98, along Tote Road	Sandy, exposed soil bank	71.33159	-82.59750	6 scattered flowering plants in close vicinity
2016	South edge of PDA near KM 84.6, along Tote Road	Sandy, exposed soil near stream	71.37605	-79.70719	13 flowering plants in close vicinity
2016	North edge of PDA near KM 84.6, along Tote road	Sandy, exposed soil near stream	71.37662	-79.70661	65 flowering and vegetative plants scattered along slope of tributary
2016	North edge of PDA and on plateau above slope near KM 84.7, along Tote Road	Sandy, exposed plateau	71.37643	-79.70499	96 flowering and vegetative plants scattered on sandy plateau
2016	South edge of PDA near KM 84.7, along Tote Road	Sandy, exposed slope	71.3761	-79.70442	150 flowering and vegetative plants scattered along edge of Tote Road
2016	South edge of PDA from approximately KM 85.1 to 85.2, along Tote Road	Sandy, exposed slope above lake	71.37571	-79.69231	420 flowering and vegetative plants scattered along edge of Tote Road

Photo 4. Horned Dandelion (*Taraxacum ceratophorum*)
A "May Be At Risk" plant species in Nunavut was found incidentally in 2014 and 2016.

2.4.3 VEGETATION AND SOIL TRACE METALS

To address Project Conditions for the NIRB Project Certificate No. 005, Baffinland established a long-term monitoring program to study metal concentrations in soil and vegetation used as caribou forage in the Project area. Data collected as part of the vegetation and soil base metals monitoring program provides additional baseline information on metals in soil and vegetation, such as lichen, for the Project.

Baseline data on vegetation and soil metal concentrations for the Project were initially collected in 2008. Most of these samples were collected in the southern portion of the Project area; only ten of which were collected from the northern portion of the Project area. The 2008 data were not used in the analysis because of discrepancies in the metals results associated with different laboratory methods and resulting minimum detection limits. In addition, the field collection methods from 2008 were not available to determine comparability to other data collected.

Vegetation and soil samples were collected in 2012, 2013, 2014 and 2016 as part of the vegetation and soil base metals monitoring program to characterize baseline metals in vegetation and soil in the Project area.

The 2012 sampling was conducted both north and south of the Project area from Steensby Inlet to Milne Port; there were a total of 35 sites visited and 36 soils and 34 lichen samples were collected.

The 2013, 2014 and 2016 sampling was conducted in the northern portion of the Project area from the Mine Site to Milne Port:

- 2013 — 20 sites, 20 soil, 17 lichen, 14 willow and four blueberry samples were collected
- 2014 — 12 sites, 12 soil, 11 lichen, 10 willow and four blueberry samples were collected
- 2016 — 50 sites, 50 soil and 50 lichen samples were collected

The vegetation and soil base metals monitoring program focused on metals in soil and lichen, mainly *Cladina*, *Cetraria*, and *Flavocetraria* species. Willow (*Salix* spp.) and blueberry (*Vaccinium uliginosum*) were considered but later removed from the program due to low availability on the landscape. Samples were tested for 33 parameters, but a subset of metals referred to as Chemicals of Potential Concern (CoPC) were chosen to represent the baseline based on the following considerations:

- Baseline metal concentrations in soils and vegetation (i.e., several metals were not detectable in soil and vegetation samples; therefore, they were not selected as CoPCs;
- Metals present in the Mary River ore — relevant metals include iron (65.88%), phosphorus, sulphur, iron oxide, manganese, and silicon and aluminum (as silicone and aluminum oxides) (FEIS Appendix 3D, Hatch 2011);
- Potential metals in road cover/road-generated dust; and
- The level of risk associated with each metal. Several sources were consulted including:
    - Canadian Environmental Quality Guidelines (provided by the Canadian Council of Ministers of the Environment [CCME]) including soil quality guidelines for both agricultural and industrial settings (CCME 2006);
    - Relevant studies on the presence, effects, and other aspects of metals in arctic and northern terrestrial biota (e.g., Canadian Arctic Contaminants Assessment Report [CACAR] 2003); and
    - Literature on vegetation and lichen-specific toxicity.

Six CoPC were selected including arsenic, cadmium, copper, lead, selenium, and zinc. Aluminum was initially considered as a CoPC but later removed due to its ubiquitous nature and lack of CCME soil quality guidelines for the protection of environmental and human health (CCME 2006). Toxicity thresholds were identified for soil and lichen for each of the six identified CoPC (Table 6). Lichen species are recognized as excellent indicators of pollutants and heavy metal contamination; however, available toxicity thresholds for lichen species in the Canadian Arctic are limited.

Determination of thresholds is further complicated by the fact that lichens are intimately tied to site conditions and exhibit species-specific tolerance to pollutants (Dillman et al. 2007); therefore, an inherent level of error must be accepted when trying to determine threshold values and values should be considered predictive.

The available thresholds may or may not be specific to species found on Baffin Island. Where species-specific thresholds could not be found, the following considerations were made: similar genus and known distribution with reference to neighbouring Arctic areas (i.e., Greenland and Nunavut). Where multiple thresholds were available for a CoPC, the lowest available threshold, in consideration of baseline concentrations, was chosen as a conservative estimate.

Table 6. Project thresholds identified for CoPC in soil and vegetation — vegetation and soil trace metals monitoring program

CoPC	Thresholds	
	Soils [1] (mg/kg)	Lichens [2] (mg/kg dry weight)
pH	6–8	-
arsenic	12	-
cadmium	1.4	30
copper	63	15
lead	70	5
selenium	1	-
zinc	200	178

[1] Thresholds based on CCME Agricultural Soil Quality Guidelines for the Protection of Environmental and Human Health

[2] Thresholds based on various sources including: (Nash 1975, Tomassini et al. 1976, Nieboer et al. 1978, Folkeson and Andersson-Bringmark 1988).

2.4.3.1 Survey Methods

Baseline vegetation data was collected from 2012-2016 as part of the vegetation and soil base metals monitoring program. This program was based on a Before-After-Control-Impact-design (BACI; Bernstein and Zalinski 1983, Stewart-Oaten et al. 1992) described in Section 2.4.2.1. The program considered three Project areas (Milne Port, Tote Road, Mine Site) at varying distances from the PDA (0–100 m; 101–1,000 m; >1,000 m). Control site locations are those that are greater than 1,000 m from the PDA. Distance classes were selected based on data from the dustfall monitoring program that indicated differences in dustfall within 100 m from the PDA and between 100–1000 m from the PDA (EDI Environmental Dynamics Inc. 2015). Beyond 1,000 m, dustfall levels were generally below laboratory detection limits. From 2012–2016, a total of 117 sites were visited of which 82 were in the northern portion of the Project area (Map 4 and Map 5). A table of all sites, locations, distance from PDA, vegetation species collected, and associated dustfall collector is provided in Attachment 3 — Vegetation and Soil Base Metals Sampling Locations.

Soil and lichen samples were collected late-July to early-August according to the following procedures:

- A new pair of nitrile gloves were worn at each sample site.
- Stainless steel tablespoons used for soil sampling were cleaned with alcohol wipes before and after each sample.
- A minimum of 10 grams of each vegetation sample was collected at each site.
- A minimum of 100 grams of soil from the top A horizon was collected at each site to a depth of ≤10 cm and above permafrost. This reflects the top layer of the rooting zone where the potential for metal uptake in plants is expected to be the greatest.
- Samples were placed in new Ziploc bags, frozen and sent to Maxxam Analytics, an accredited laboratory (ISO/IEC 17025:2005), for metals analyses by ICP-MS.

Cladina (Photo 5), *Cetraria*, and *Flavocetraria* genera were collected for lichen metals analyses. These lichens are consumed by caribou and represent important winter forage.

Photo 5. *Cladina* a typical lichen collected as part of the vegetation and soil base metals monitoring program.

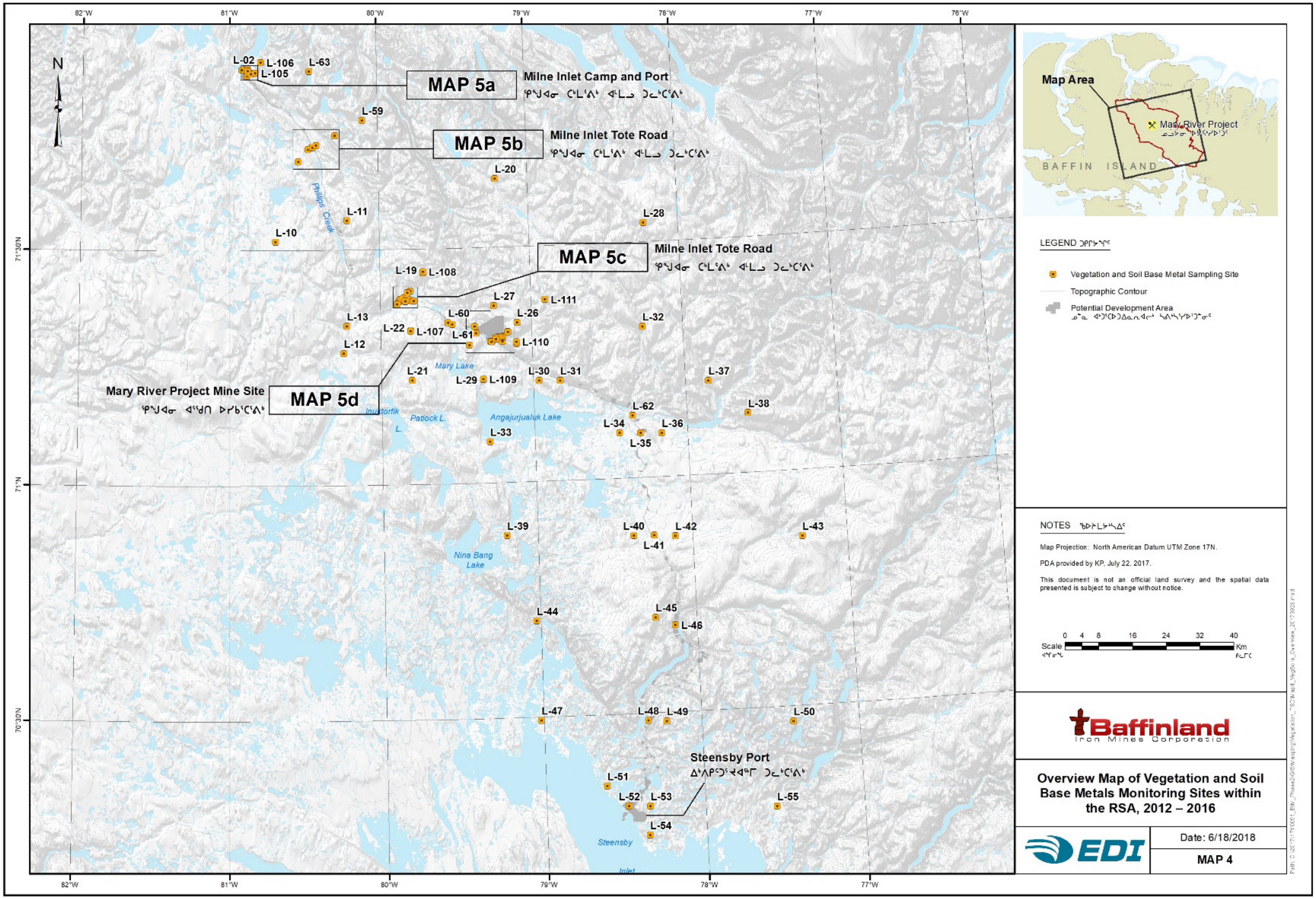
2.4.3.2 Data Analysis

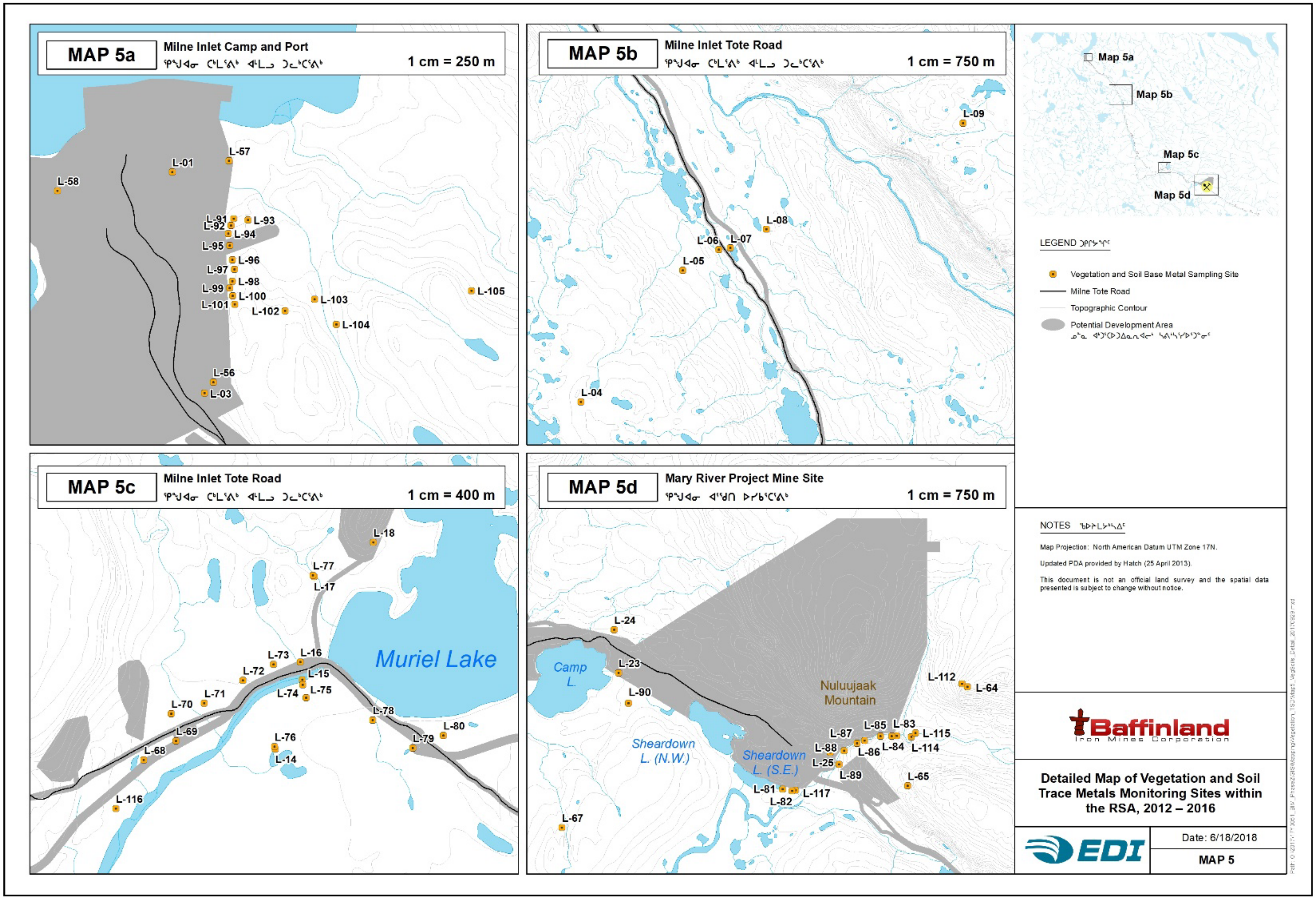
Soil and lichen samples were analyzed for total metal concentrations using inductively coupled plasma mass spectrometry (ICP-MS) by an accredited laboratory. To conform to earlier baseline methods, soil and lichen samples were analyzed for 33 elements. Lichen was analyzed for the following metals: aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, strontium, thallium, tin, titanium, uranium, vanadium, and zinc. Excluding boron, soil analysis included the same suite of metals, with the addition of lithium, zirconium and soil pH. Full data sets of vegetation and soil metal analyses from 2012–2016 sampling are provided in Attachment 4 — Laboratory Results: Metals in Soil and Vegetation.

One-way ANOVA was used to test for differences in metal concentrations based on sampling area. The five sampling areas included:

- Mine Site — within 100 m of the Mine Site
- Tote Road — within 100 m of the Tote Road
- Milne Port — within 100 m of the Milne Port
- Far — between 100 m and 1,000 m of planned infrastructure
- Control — greater than 1,000 m from planned infrastructure

Metal concentrations were log-transformed prior to analysis to achieve statistical assumptions of normality and equal variance. Samples that were below the minimum detection limit (MDL) were assigned a value of half the MDL for statistical analyses. Medians and 95% confidence intervals were reported on the normal scale and compared to the threshold for each metal. Residual and qq-plots were visually examined to confirm that assumptions were met for each test. Analyses were performed using R, version 3.3.1 (R Core Team 2014).


MAP 5a
Milne Inlet Camp and Port
MAP 5b
Milne Inlet Tote Road
MAP 5c
Milne Inlet Tote Road
MAP 5d
Mary River Project Mine Site
Steensby Port
Mary Lake
Angajurjualuk Lake
Nina Bang Lake
Phillips Creek
Patiock L.
Steensby Inlet
Map Area
Mary River Project
BAFFIN ISLAND
LEGEND
Vegetation and Soil Base Metal Sampling Site
Topographic Contour
Potential Development Area
NOTES
Map Projection: North American Datum UTM Zone 17N.
PDA provided by KP, July 22, 2017.
This document is not an official land survey and the spatial data presented is subject to change without notice.
Scale 0 4 8 16 24 32 40 Km
Baffinland Iron Mines Corporation
Overview Map of Vegetation and Soil Base Metals Monitoring Sites within the RSA, 2012 – 2016
EDI
Date: 6/18/2018
MAP 4


MAP 5a
Milne Inlet Camp and Port
1 cm = 250 m
L-01
L-03
L-56
L-57
L-58
L-91
L-92
L-93
L-94
L-95
L-96
L-97
L-98
L-99
L-100
L-101
L-102
L-103
L-104
L-105
MAP 5b
Milne Inlet Tote Road
1 cm = 750 m
L-04
L-05
L-06
L-07
L-08
L-09
MAP 5c
Milne Inlet Tote Road
1 cm = 400 m
Muriel Lake
L-14
L-15
L-16
L-17
L-18
L-68
L-69
L-70
L-71
L-72
L-73
L-74
L-75
L-76
L-77
L-78
L-79
L-80
L-116
MAP 5d
Mary River Project Mine Site
1 cm = 750 m
Camp L.
Sheardown L. (N.W.)
Sheardown L. (S.E.)
Nuluujaak Mountain
L-23
L-24
L-25
L-64
L-65
L-67
L-81
L-82
L-83
L-84
L-85
L-86
L-87
L-88
L-89
L-90
L-112
L-114
L-115
L-117
Map 5a
Map 5b
Map 5c
Map 5d
LEGEND
Vegetation and Soil Base Metal Sampling Site
Milne Tote Road
Topographic Contour
Potential Development Area
NOTES
Map Projection: North American Datum UTM Zone 17N.
Updated PDA provided by Hatch (25 April 2013).
This document is not an official land survey and the spatial data presented is subject to change without notice.
Baffinland
Iron Mines Corporation
Detailed Map of Vegetation and Soil Trace Metals Monitoring Sites within the RSA, 2012 – 2016
EDI
Date: 6/18/2018
MAP 5

2.4.3.3 Results and Discussion

From 2012 through 2016 there were a total of 87 soil samples and 79 lichen samples collected (Table 7). The CCME agricultural and industrial soil quality guidelines recommend a pH range of 6 – 8 in soil. Approximately half of the samples (53%) were either below (25 samples) or above (21 samples) this recommended range. Soil with a pH outside of the identified range can affect the bioavailability of certain metals. The normal pH range for highly productive soils is generally restricted from 5.5 to 8, but can extend from 4 to 9 for all soils in the general environment (Langmuir et al. 1983). Low pH can cause toxicity in soil and vegetation, due to greater bioavailability of certain metals (Langmuir et al. 1983, Chaney and Ryan 1993, Braune et al. 1999). It is known that acidic soils increase plant uptake of zinc and cadmium and increase the potential for phytotoxicity from copper and zinc (Chaney and Ryan 1993). Alternatively, alkaline soil pH increases uptake of selenium while lead is not absorbed to a large extent at any pH.

Concentrations of CoPC in all soil and lichen samples were below Project-specific thresholds in all sampling areas except for one soil and one lichen sample. The threshold for copper in soil was exceeded at site L-91 in 2016 with a concentration of 116 mg/kg within 100 m of Milne Port (Table 7). This elevated concentration was likely associated with sampling or analytical procedures given that copper concentrations were considerably lower at nearby sample sites L-92 (2.02 mg/kg) and L-94 (5.72 mg/kg). The threshold for lead in lichen was exceeded at site L-71 in 2016; the sample had a concentration of 6.04 mg/kg within 100 m of Tote Road (Table 7). Though the lead concentration from this sample was elevated in comparison with other 2016 data, there was a sample collected in 2014 from L-64 (a control site) with a concentration of 6.71 mg/kg. Given the heterogeneous nature of vegetation sampling, there is the potential for some samples with elevated concentration of lead and other metals. In comparison, concentrations of lead from nearby sample sites L-69 (2.58 mg/kg), L-70 (1.43 mg/kg), and L-72 (2.56 mg/kg) were well below the threshold.

Soil metals concentrations were all below applicable CCME guidelines (Figure 10). Soil metal concentrations were generally higher within the Near distance category (100 m from PDA) than the Far distance category (101–1,000 m from PDA). Differences in soil metal concentrations included:

- Median arsenic was higher within 100 m of Milne Port than Tote Road ($p = 0.019$) and the Far sampling area ($p = 0.027$);
- Cadmium concentrations were higher within 100 m of Milne Port and the Control sampling area than within 100 m of Tote Road ($p<0.02$);
- Sites within 100 m of Milne Port and the Control sampling area had the highest median concentrations of copper, significantly higher than Tote Road and the Far sampling area ($p<0.015$);
- Sites within 100 m of the Mine Site, Milne Port, and the Control sampling area had the highest median concentrations of lead, significantly higher than Tote Road and the Far sampling area ($p<0.016$); and
- Sites within 100 m of Milne Port and the Control sampling area had the highest median concentration of zinc, significantly higher than within 100 m of Tote Road and the Far sampling area ($p<0.047$).

Metal concentrations in lichen were generally higher within the Near distance category (100 m from PDA) than the Far (101–1,000 m from PDA) and Control (>1,000 m from PDA) distance category (Figure 11). Differences in lichen metal concentrations included:

- Median concentrations of arsenic were higher within 100 m of Tote Road than at Milne Port, Far, and Control sampling areas (all $p<0.001$);
- Median copper concentrations within 100 m of Tote Road and the Mine Site were higher than at Milne Port, Far, and Control sampling areas (all $p<0.01$);
- Median lead concentrations within 100 m of Tote Road were higher than the Far and Control sampling areas (all $p<0.001$); and
- Selenium concentrations within 100 m of Tote Road and Milne Port were higher than the Far sampling area (all $p<0.03$) but were not different from the Mine Site and Control sampling area ($p>0.34$).

Table 7. Summary of vegetation and soil trace metals monitoring results, 2012–2016.

Contaminant of Potential Concern (CoPC)	No. of Samples	Below MDL (%)	Median (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)	Threshold [1] (mg/kg)	No. of Samples above Threshold
Soil							
As	87	51.7	0.500	<0.500	4.140	12	0
Cd	87	47.1	0.057	<0.050	0.275	1.4	0
Cu	87	2.30	3.58	<0.50	116	63	1
Pb	87	0	3.45	0.54	11.2	70	0
Se	87	100	<0.5	<0.5	<0.5	1	0
Zn	87	1.15	11.4	<0.5	39.6	200	0
Lichen							
As	79	25.3	0.122	<0.096	0.352	-	-
Cd	79	0	0.042	0.035	0.192	30	0
Cu	79	0	1.220	0.661	5.340	15	0
Pb	79	0	1.020	0.218	6.040	5	1
Se	79	21.5	0.062	<0.05	0.142	-	-
Zn	79	0	12.7	6.47	33.2	178	0

[1] Thresholds are described in Table 6.

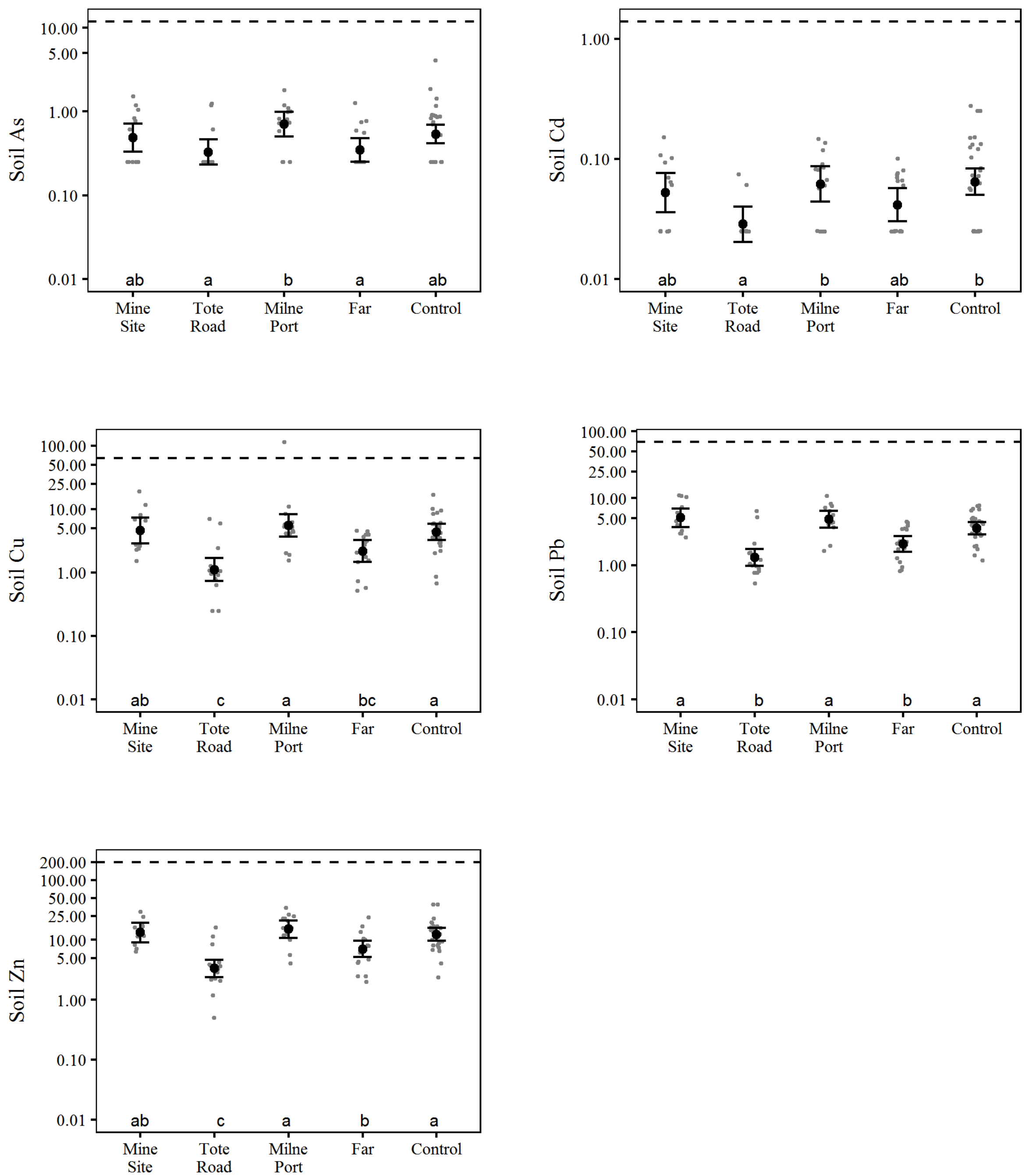


Figure 10. Metal concentrations (mg/kg) in soil by sampling area.

Large symbols indicate medians, small symbols indicate individual samples, and error bars are 95% confidence intervals for the median. Common letters along the bottom axis indicate groups with overlapping confidence intervals. The y-axis is displayed on a log-scale. The horizontal line indicates the threshold. No horizontal line indicates threshold is well above current concentrations.

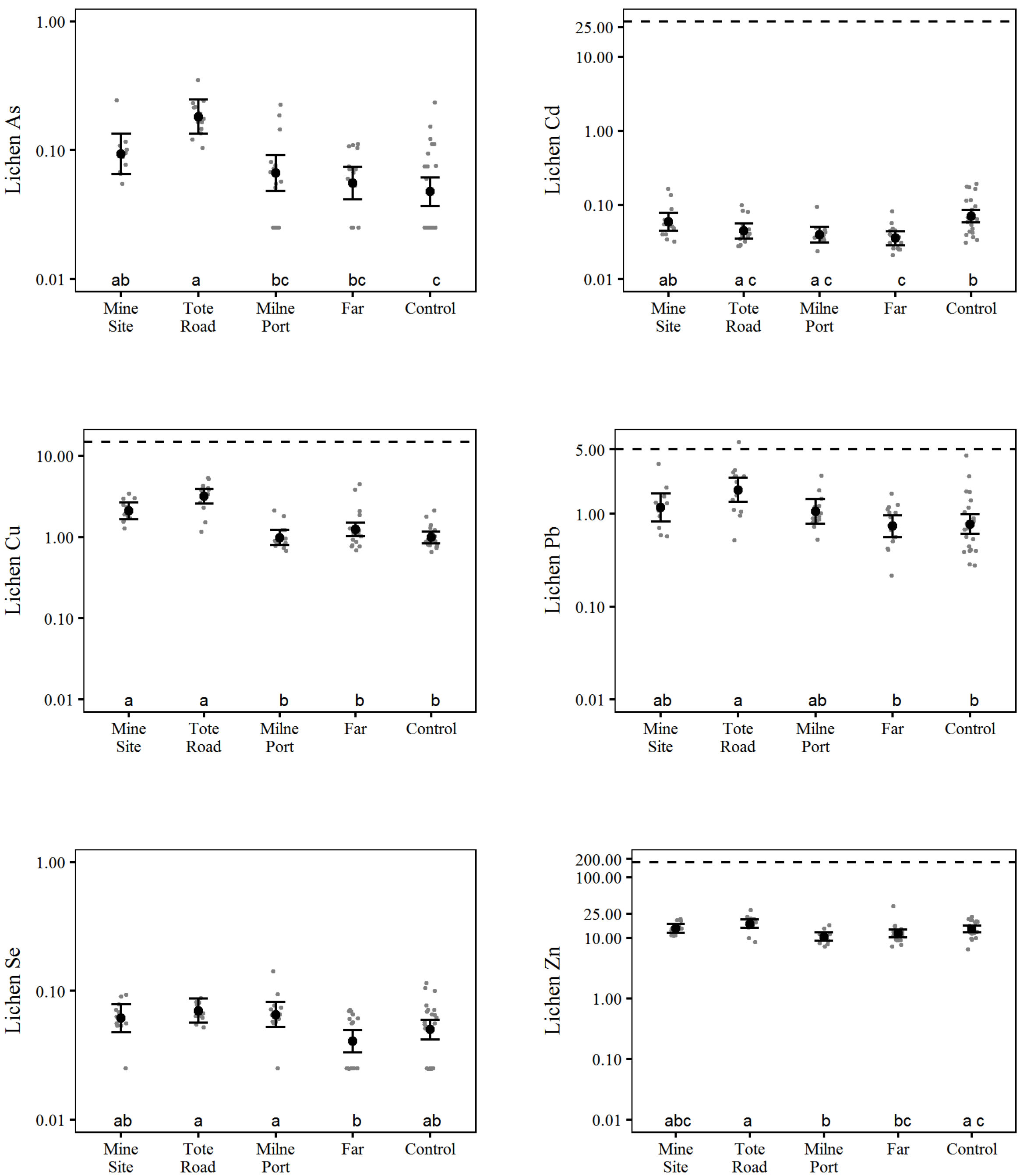


Figure 11. Metal concentrations (mg/kg) in lichen by sampling area.

Large symbols indicate medians, small symbols indicate individual samples, and error bars are 95% confidence intervals for the median. Common letters along the bottom axis indicate groups with overlapping confidence intervals. The y-axis is displayed on a log-scale. The horizontal line indicates the threshold. No horizontal line indicates threshold is well above current concentrations.

2.4.4 EXOTIC INVASIVE VEGETATION

To address Project Conditions for the NIRB Project Certificate No. 005, Baffinland established a long-term monitoring program to survey for potential exotic invasive vegetation in the Project area. Data collected as part of the exotic invasive vegetation monitoring program provides baseline information on the presence/absence of exotic invasive vegetation in the Project area.

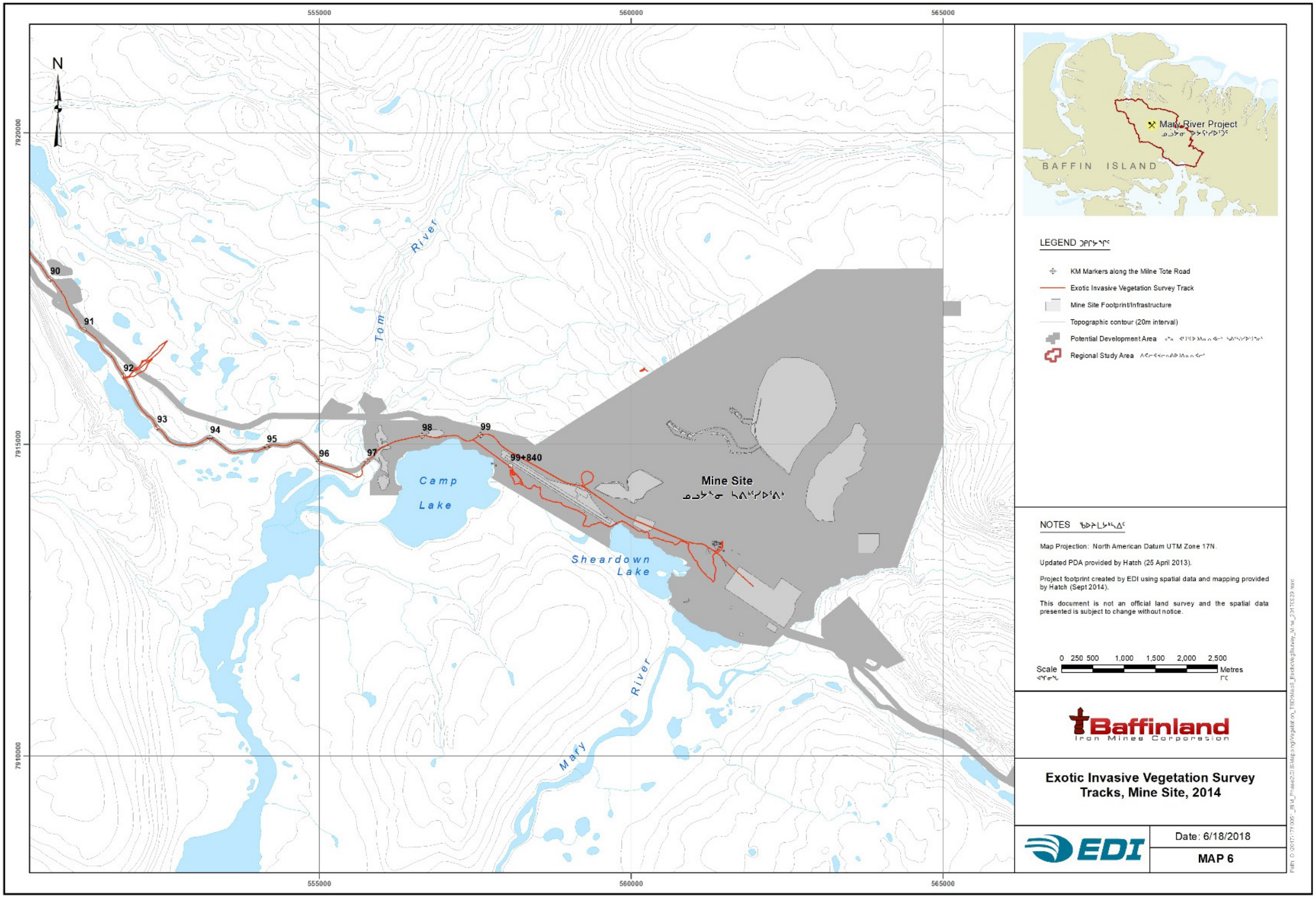
Based on available information, exotic plant species have not yet been identified on northern Baffin Island (Saarela 2014). Exotic species are species found outside of their natural range, often as a result of human activity (Government of Canada 2013). These species may not pose an immediate risk; however, some can become invasive (YISC 2014) and have the potential to pose negative impacts to the environment and economy (NatureServe 2014).

In response to the concern of exotic invasive plants associated with the Project area, EDI prepared the Baffinland Field Guide to Exotic Plant Species Identification in 2013. The guide was developed to assist Baffinland field personnel in the identification of 14 potential exotic invasive plant species. The 14 plant species highlighted in the guide were based on a list of exotic species provided by the Government of Nunavut (Government of Nunavut [GN] 2013) and can be referenced in Attachment 5 — Exotic Plant Species Known to Nunavut. For more information on the Baffinland Field Guide to Exotic Plant Species Identification in 2013 refer to Attachment 6.

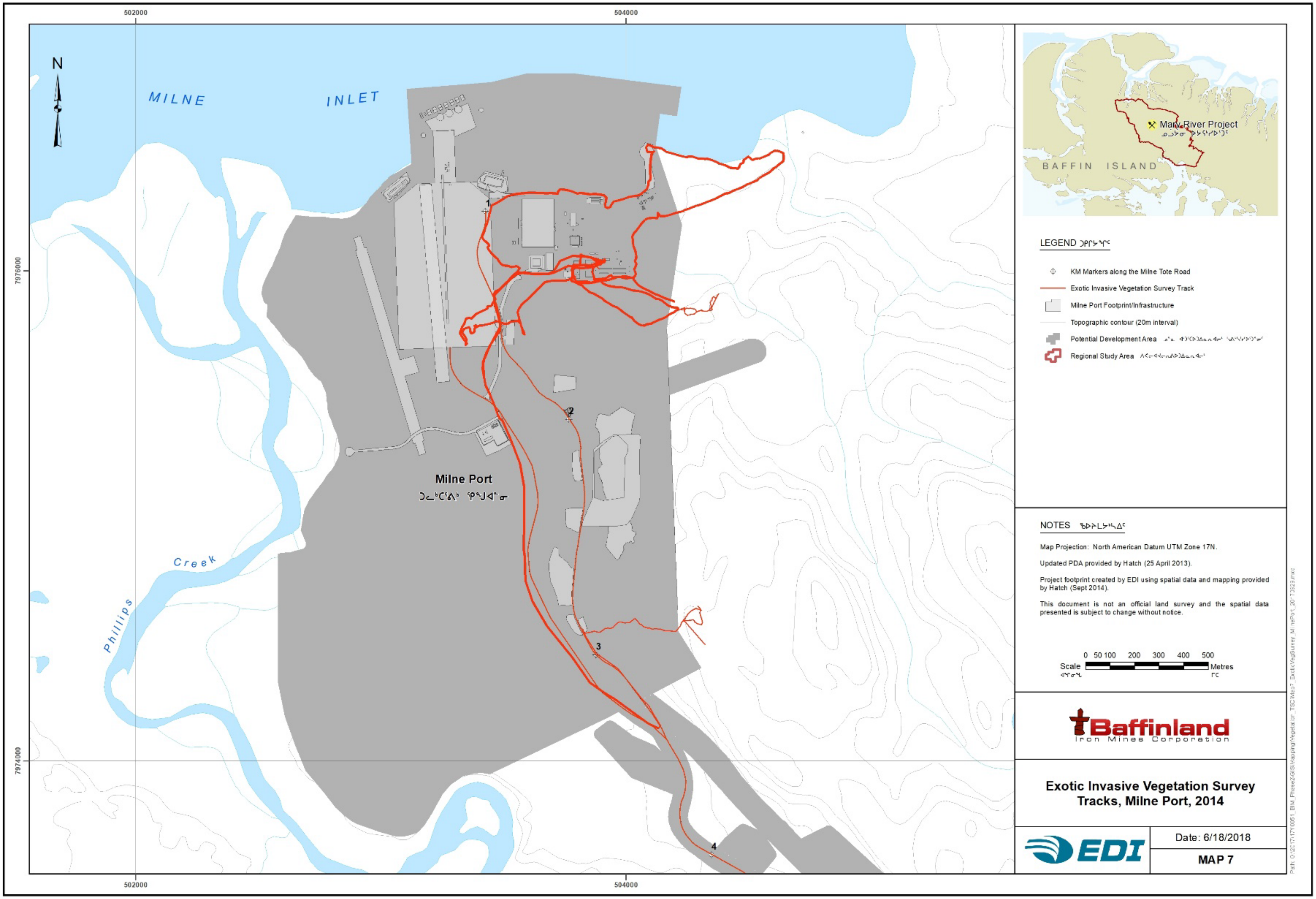
2.4.4.1 Survey Methods

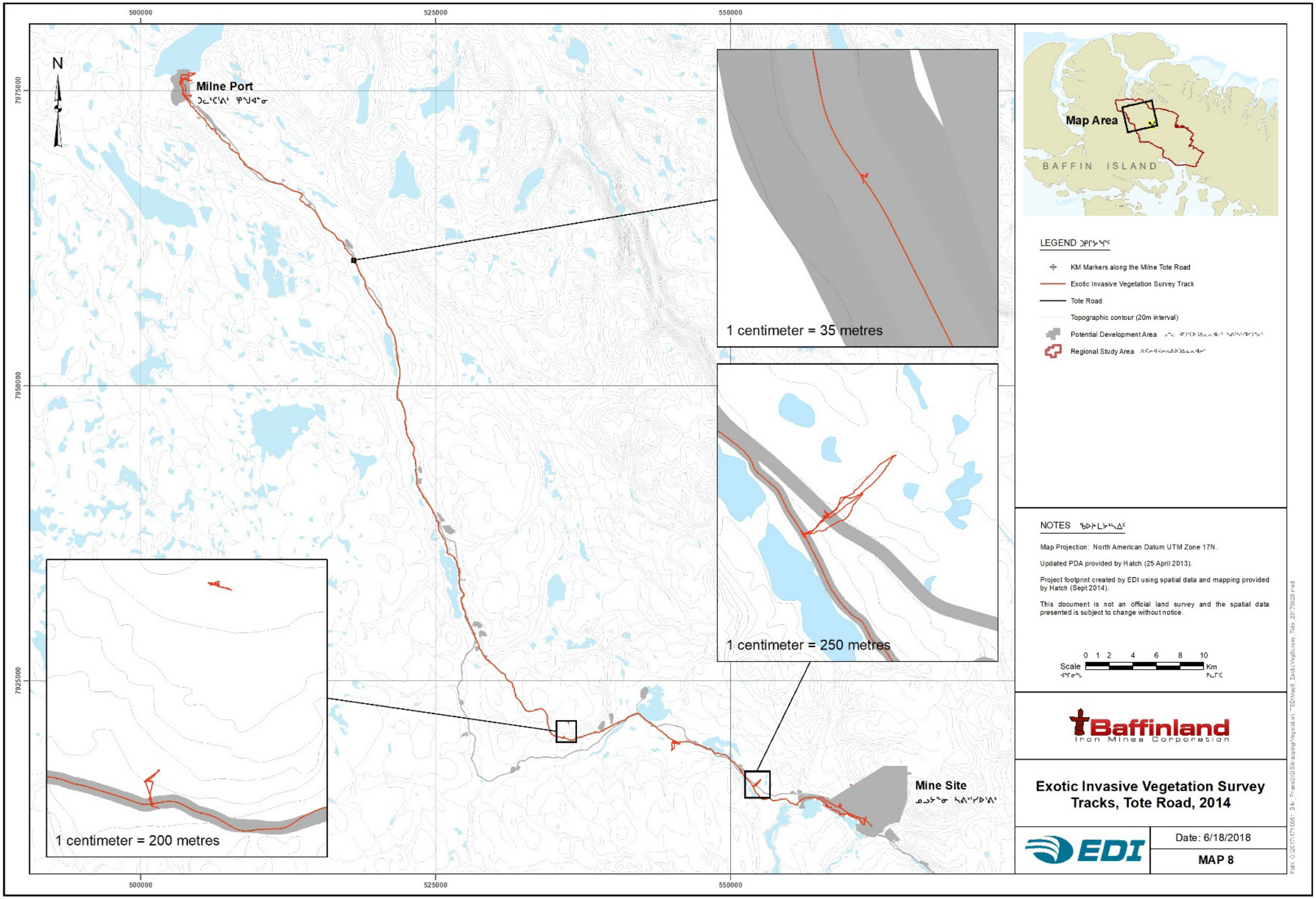
Baseline vegetation data was collected August 1–3, 2014 as part of the exotic invasive vegetation monitoring program. Field surveys focused on previously disturbed areas within and adjacent to the Project footprint including the Mine Site (Map 6), Milne Port (Map 7), and the Tote Road (Map 8). Given that there are no known exotic invasive plant species on Baffin Island, it was not necessary to extend the survey beyond the Project footprint at this time.

Presence/absence sampling was used to search for exotic invasive vegetation, as it is an efficient and targeted method for surveying exotic invasive plants (Oldham 2007, ANPC 2012, Government of Alberta 2014). This method involved extensive surveys targeting disturbed habitats where exotic invasive plants could be found (i.e., disturbance areas along buildings, infrastructure and road ditches). Areas were surveyed on foot with some sections surveyed in a vehicle at slow speeds along the Tote Road. Each of the three focal areas (Milne Port, Mine Site, and Tote Road) were surveyed by two qualified botanists and one local assistant for 10 hours each, totaling 30 hours of survey time per focal area.



N
90
91
92
93
94
95
96
97
98
99
99+840
Tom River
Camp Lake
Sheardown Lake
Mary River
Mine Site
555000
560000
565000
7920000
7915000
7910000
Mary River Project
BAFFIN ISLAND
LEGEND
KM Markers along the Milne Tote Road
Exotic Invasive Vegetation Survey Track
Mine Site Footprint/Infrastructure
Topographic contour (20m interval)
Potential Development Area
Regional Study Area
NOTES
Map Projection: North American Datum UTM Zone 17N.
Updated PDA provided by Hatch (25 April 2013).
Project footprint created by EDI using spatial data and mapping provided by Hatch (Sept 2014).
This document is not an official land survey and the spatial data presented is subject to change without notice.
Scale
0 250 500 1,000 1,500 2,000 2,500
Metres
Baffinland
Iron Mines Corporation
Exotic Invasive Vegetation Survey Tracks, Mine Site, 2014
EDI
Date: 6/18/2018
MAP 6


MILNE INLET
Creek
Phillips
Milne Port
Mary River Project
BAFFIN ISLAND
LEGEND
KM Markers along the Milne Tote Road
Exotic Invasive Vegetation Survey Track
Milne Port Footprint/Infrastructure
Topographic contour (20m interval)
Potential Development Area
Regional Study Area
NOTES
Map Projection: North American Datum UTM Zone 17N.
Updated PDA provided by Hatch (25 April 2013).
Project footprint created by EDI using spatial data and mapping provided by Hatch (Sept 2014).
This document is not an official land survey and the spatial data presented is subject to change without notice.
Scale 0 50 100 200 300 400 500 Metres
Baffinland Iron Mines Corporation
Exotic Invasive Vegetation Survey Tracks, Milne Port, 2014
EDI
Date: 6/18/2018
MAP 7


500000
525000
550000
7975000
7950000
7925000
N
Milne Port
Mine Site
1 centimeter = 35 metres
1 centimeter = 250 metres
1 centimeter = 200 metres
Map Area
BAFFIN ISLAND
LEGEND
KM Markers along the Milne Tote Road
Exotic Invasive Vegetation Survey Track
Tote Road
Topographic contour (20m interval)
Potential Development Area
Regional Study Area
NOTES
Map Projection: North American Datum UTM Zone 17N.
Updated PDA provided by Hatch (25 April 2013).
Project footprint created by EDI using spatial data and mapping provided by Hatch (Sept 2014).
This document is not an official land survey and the spatial data presented is subject to change without notice.
0 1 2 4 6 8 10
Scale
Km
Baffinland
Iron Mines Corporation
Exotic Invasive Vegetation Survey Tracks, Tote Road, 2014
EDI
Date: 6/18/2018
MAP 8

2.4.4.2 Results and Discussion

No exotic invasive vegetation species were found during surveys of the Project footprint and adjacent areas. Field crews surveyed all three focal areas including the Mine Site, Milne Port, and Tote Road. The perimeter of the Mine Site and Milne Port were surveyed on foot, which included laydown areas, the batch plant, the incinerator, the landfill, along the airstrip, and around the Weatherhaven™ camp, Mary River camp (Photo 6), and both the Matrix camp and main camp at Milne Port (Photo 7). Areas of active construction, heavy equipment use and blasting were not surveyed due to safety concerns. Survey site selection considered level of ground disturbance and locations of high human/vehicle activity.

The Tote Road was driven from the Mine Site to Milne Port with one person on each side of the vehicle observing the edges and ditches along the road. Sites along the road where crews surveyed on foot for potential exotic invasive plant species included bridges, culverts, pullouts, the old road near km 75 (Photo 8) and the sea can storage area near km 96.5.

Photo 6. Disturbed area surveyed around Mary River camp for exotic invasive vegetation, 1 Aug 2014.

Photo 7. Disturbed area surveyed around Milne Port for exotic invasive vegetation, 3 Aug 2014.

Photo 8. Old road segment along Tote Road surveyed for exotic invasive vegetation, 2 Aug 2014.

2.4.5 REVEGETATION OBSERVATIONS

Observations of natural revegetation were made during exotic invasive vegetation surveys at disturbed sites where vegetation cover had been previously removed due to natural or human caused activities. These observations provide additional baseline information on the status and potential for revegetation of disturbed areas by native species in the Project area.

2.4.5.1 Results and Discussion

At recently disturbed areas, little to no vegetation was found growing (i.e., new pullouts along Tote Road or exposed soil at Mary River camp or Milne Port). Some native plant species were found revegetating older disturbed areas (i.e., the old road segment near kilometre 75 and an old archaeological dig west of the Tote Road near Milne Port). Disturbed soil around the Weatherhaven™ camp at the Mine Site showed signs of revegetation; a common species found recolonizing around the edges of buildings was long-stalked starwort (*Stellaria longipes*; Photo 9; Photo 10). Dominant native plants that were found revegetating older disturbed areas throughout the Project area are provided in Table 8.

Photo 9. Example of natural revegetation occurring around the edges of buildings at the Weatherhaven™ camp, Mine Site, 2014.

Photo 10. Long-stalked starwort (*Stellaria longipes*) a common native plant found recolonizing disturbed soil around buildings at the Weatherhaven camp, Mine Site, 2014.

Table 8. Native plant species found revegetating old disturbed areas within the Project footprint, 2014.

Common name (Scientific name)	Mine Site	Milne Port	Tote Road
Alpine fescue (*Festuca brachyphylla*)		•	•
Arctic bladderpod (*Physaria arctica*)	•		
Arctic mouse-ear chickweed (*Cerastium arcticum*)			•
Glaucous bluegrass (*Poa glauca*)			•
Long-stalked starwort (*Stellaria longipes*)		•	
Mountain sorrel (*Oxyria digyna*)			•
Polar grass (*Arctagrostis latifolia*)	•	•	
Purple saxifrage (*Saxifraga oppositifolia*)	•		
Snow whitlow grass (*Draba nivalis*)	•		
Spiked trisetum (*Trisetum spicatum*)		•	•

2.5 VEGETATION CHARACTERISTICS SUMMARY

Vegetation associated with the Project area within the terrestrial RSA can be summarized as follows:

- The Project is located on northern Baffin Island in the Northern Arctic terrestrial ecozone of Canada.
- The Project area falls within three ecoregions (1) Borden Peninsula Plateau (2) Baffin Island Uplands and (3) Melville Peninsula Plateau; the Project area is mainly within the Melville Peninsula Plateau.
- The climate is cold and dry with little precipitation, high winds, shallow soils, and sparse vegetation cover.
- The landscape is characterized by non-mountainous terrain including dry, rugged uplands, rolling plains, and lowland features with continuous permafrost and sparse vegetation cover.
- There are 11 out of 13 NLC classes in the Project area; the most common is the sparsely vegetated bedrock cover type which contains 2–10% vegetation cover and generally consists of graminoids and prostrate dwarf shrubs and the second most common is the prostrate dwarf shrub cover type which typically contains >25% vegetation cover and is made up of prostrate dwarf shrubs, graminoids, and may contain <10% lichen and moss.
- Baseline vegetation surveys have been conducted in the Project area since 2005; monitoring work has been ongoing since 2012.
- Vegetation surveys completed in the Project area as part of baseline and project monitoring include inventory of:
  - Vegetation species, communities, abundance, composition and rare plants;
  - Vegetation and soil trace metals;
  - Revegetation by native plant species;
  - Inuit Qaujimajatuqangit (IQ) based traditional plant use studies; and
  - Exotic invasive vegetation.

The information provided in this baseline vegetation report informs an environmental effects assessment on vegetation for the Phase 2 Proposal.

3 IMPACTS ON VEGETATION

3.1 INUIT COMMUNITY AND STAKEHOLDER COMMENTS

Vegetation was identified as a Valued Ecosystem Component (VEC) based on its potential to interact with the Project, and its ecological, social and legislated importance.

In 2015, the Nunavut Impact Review Board (NIRB) prepared guidelines that reflected many of the concerns associated with effects on vegetation. The NIRB guidelines (Section 8.1.8.1, (Nunavut Impact Review Board 2015) were associated with concerns of overall effects on plant abundance, diversity, health, and use by humans, and directed Baffinland to characterize the potential impacts on abundance and diversity, forage quality, fugitive dust, etc.

Since 2012, potential Project effects on vegetation have been discussed within the Terrestrial Environment Working Group (TEWG, described below). The group was formed to consider the monitoring efforts of results to address various Project Certificate No. 005 Terms and Conditions related to the terrestrial environment. Those related to vegetation (e.g., 31–40) reflect the various concerns expressed by the intervenors during the Approved Project review and include terms to minimize the Project footprint, controls for invasive plant species, monitoring for metals in plants, caribou forage, and vegetation reclamation. Addressing the monitoring requirements and discussions within that group have informed the vegetation effects assessment on aspects such as a continued focus on effects of dust deposition, lichen cover, and metals in plants and soils.

Outside of TEWG discussions, Inuit community and stakeholder concerns related to the Phase 2 Proposal have not focused on the vegetation VEC. The concerns raised during consultation on the Approved Project were primarily related to vegetation abundance and diversity, vegetation health, and culturally valued vegetation.

3.2 PROJECT INTERACTIONS WITH VEGETATION

Vegetation abundance and diversity is affected through direct or indirect loss. Direct loss of vegetation will occur within the Project footprint and indirect loss of vegetation could occur from project infrastructure that cause changes to the microclimate directly adjacent to these areas. Dust deposition and emission could also have the potential to cause a change in vegetation abundance and diversity. No vegetation species of conservation concern have been encountered in baseline or monitoring inventories and they are not considered a Project-specific concern.

Vegetation Abundance and Diversity — Approximately 184 plant species (and associated subspecies) including vascular and non-vascular plants have been recorded by vegetation surveys completed from 2005 to 2016. This list does not include all non-vascular species (lichens and mosses). Phase 2 Proposal activities that may interact with and directly affect vegetation abundance and diversity include clearing and grubbing within new areas of the Project footprint.

Indirect changes on vegetation abundance and diversity that have the potential to occur during the Phase 2 Proposal are similar to those described in the 2012 FEIS (Baffinland Iron Mines Corporation 2012) include the potential for introduction of invasive plant species, changes to surface drainage, permafrost, erosion and snow accumulation patterns. Those effects are expected to be localized with close proximity to the Project's footprint.

Caribou forage includes lichens and green forage in the snow free season. Given the importance of caribou to the local communities, the Project's potential direct and indirect impacts on caribou forage are a continuing concern addressed in ongoing monitoring and in this impact assessment.

The new disturbances associated with the Phase 2 Proposal will contribute to a further reduction in plant abundance and diversity (Table 9). The PDA of the Phase 2 Proposal will increase by 16.5% relative to the PDA of the Approved Project.

Table 9. Phase 2 Proposal Potential Development Area disturbed area summary

Project Component	Approved Project PDA (km^2)	Change from Phase 2 PDA (km^2)	Phase 2 Proposal (km^2)	Comment
Milne Port (land)	2.24	3.78	+1.54	Includes additional area for landfill and rail terminus
Milne Port (water)	0.20	0.22	+0.02	Includes the second ore dock
Tote Road[1]	8.65	8.91	+0.26	Based on 40 m buffer on either side of centreline
North Rail	0	13.10	+13.10	Based on 50 m either side of the centreline and 25 m buffer on laydown and quarry features
Mine Site	27.39	27.39	0	No change
South Rail[2]	27.22	27.22	0	No change
Steensby Port	24.82	24.82	0	No change
Total	90.52	105.44	+14.92	A 16.48% increase in PDA

Note(s):

1. The tote road PDA of 8.65 km^2 reported in the FEIS included overlap with the Mine Site and Milne Port PDA. The value included in this table for the Phase 2 PDA represents the current Tote Road PDA with no overlap.
2. The south rail PDA includes the footprint for the rail alignment (40 m buffer), construction access road (40 m buffer) and quarries.

Vegetation Health — There is the potential that vegetation health could be affected by dust deposition and incomplete combustion emissions. A change in vegetation health could occur due to dust inhibiting plant function or due to uptake of metals found in dust directly on plant tissue or through absorption of metals from the soil via plant roots. Vegetation can uptake incomplete combustion emission by-products, through accumulation of available nitrogen, or be indirectly affected by a change in soil pH from acid deposition.

Some of the direct effects of dust on plants include blocking or covering of the stomata and potential decrease in photosynthesis and chlorophyll production (Spatt and Miller 1981) which can result in a physical inhibition of plant function. Inhibition of plant function can result in reduction in plant growth and health.

A potential direct effect of high concentration of atmospheric or deposited nitrogen is that toxic levels have the potential to alter chemical and metabolic processes in plants that can also result in the reduction of plant growth and an increase in plant susceptibility to environmental stresses (Mansfield 2002). Nitrogen deposited on the soil can acidify the soil overtime and this change in soil chemistry has the potential to affect vegetation abundance and diversity by altering plant species competitive abilities (Ashenden 2002).

The Project also has the potential to increase sulphur emissions to the environment mostly from fuel combustion and refuse incineration. Emissions will mostly be in the form of sulphur dioxide (SO_2) which can be detrimental to vegetation health. The duration and frequency of the SO_2 exposure will determine the extent of the effect to plants.

Culturally Valued Vegetation — There is the potential that construction, operation, and closure of Phase 2 activities could affect culturally valued vegetation but all the direct effects to these plant species will occur within the PDA. Indirect effects to plants within the RSA that are currently valued and harvested by Inuit due to Project activities are expected to be negligible.

3.3 ASSESSMENT METHODS

The methods used for the effects assessment of Phase 2 Proposal's activities on vegetation are consistent with the FEIS (Volume 6, Section 3.2.1). The assessment of the Phase 2 Proposal's effect on vegetation is based on three Key Indicators (KIs) and all measurable parameters are assessed using quantitative procedures:

- Vegetation Abundance and Diversity
- Vegetation Health
- Culturally Valued Vegetation

The assessment of Phase 2 Proposal related effects addresses the following measurable parameters:

- Footprint assessment for vegetation loss
- Dustfall deposition outside of PDA effect on change to vegetation
- Footprint and dustfall effect on NLC classes/NLC classes likely sensitive to emissions
- Footprint and dustfall effect on NLC classes likely to contain culturally important plants

The magnitude of the effects from Phase 2 Proposal activities were determined relative to the scale of occurrence within the RSA, as described further in Section 3.3.4.

3.3.1 VEGETATION ABUNDANCE AND DIVERSITY

As with the FEIS assessment, this assessment also makes three assumptions to simplify the assessment for quantifying the effects of the Phase 2 Proposal on vegetation abundance and diversity:

- The new disturbance within the proposed Phase 2 Proposal footprint will remove all vegetation within the entire PDA for the life of the Project;
- Although much of the RSA can be considered sparsely vegetated or barren, all land is terrestrial habitat and as such considered potentially vegetated; and
- Regeneration of disturbed areas is a naturally-occurring slow process and therefore complete regeneration will not occur until beyond the life of the Project.

The assessment of predicted Project effects on vegetation abundance and diversity is based on the amount of new disturbance that the Project will cause and the diversity of vegetation, as described by plant community types identified by the NLC mapping. The predicted loss in vegetation abundance due to Phase 2 Proposal activities is quantified by subtracting the PDA area from the RSA area. The results show the change in terrestrial habitat due to the Project activities that will remove vegetation. The predicted loss in vegetation diversity due to Phase 2 Proposal activities is quantified by comparing the area represented by each of the plant communities identified by the NLC mapping before and after the construction of the railway and other Phase 2 Proposal activities within the RSA. The effect is summarized relative to the availability of the NLC classes in the RSA.

3.3.2 VEGETATION HEALTH

The effects of the Phase 2 Proposal activities on vegetation health is assessed by use of the most currently available thresholds for each contaminant beyond which effects on plant health are known or suspected to occur.

Dust — Total Suspended Particulate (TSP) — Currently there are no known dust deposition threshold values specific to effects on plants. According to Health Canada/Environment Canada (CEPA/FPAC Working Group 1998) it is not possible to define a reference level for vegetation and dust deposition because of the lack of quantitative dose-effect information currently available. Due to the lack of established thresholds for dust effects on vegetation, values from other development and research projects were explored. In the High Lake Project which is a proposed base metal mine in western Nunavut, Wolfden Resources Inc. (Wolfden Resources Inc. 2006) developed annual thresholds for the magnitude of dust deposition rates on vegetation health. The developed magnitude ranges from a low magnitude of effect of 4.6 g/m²/a to a high magnitude of effect of ≥ 50 g/m²/a (Table 10). Studies completed by Spatt and Miller (1981) demonstrate a decline in species abundance with a daily dust deposition rate of 1.0 to 2.5 g/m²/d and on some plant species observed some effects of dust deposition rates of 0.07 to 1.0 g/m²/d (Table 10). From a human health perspective, the Ontario government has an annual deposition criterion of 4.6 g/m²/a and the Alberta government has a dust deposition criterion for recreational and residential areas of 5.3 g/m²/30 d (Table 10).

Based on the information collected, it was decided to use the following annual TSP deposition thresholds to quantify potential effects from TSP deposition on vegetation health:

Low: 1.0 – 4.6 g/m²/a;

Moderate: > 4.6 – 50 g/m²/a; and

High: > 50 g/m²/a

Table 10. Dust deposition rates and criteria for potential effects on vegetation health

Source of Information	Dust (TSP) deposition rate	Equivalent annual dust deposition rate (g/m²/a)	Comments
High Lake Impact Assessment (Wolfden 2006)	1.0 – 4.6 g/m²/a	1.0 – 4.6	Predicted low magnitude effect on vegetation health
	4.6 – 50 g/m²/a	4.6 – 50	Predicted moderate magnitude effect on vegetation health
	50 – 200 g/m²/a	50 – 200	Predicted high magnitude effect on vegetation health
Spatt and Miller (1981)	0.07 g/ m²/d	26	Some effects to *Sphagnum* species
	1.0 – 2.5 g/ m²/d	365 – 913	Decline in *Sphagnum* species
Alberta	5.3 g/ m²/30 d	64	Alberta Guidelines for Residential and Recreational Areas (human health)
Ontario	4.6 g/m²/a	4.6	Ontario Ambient Air Quality Criteria (human health)

Metals in Dust — Similar to dust deposition thresholds for vegetation, thresholds that link atmospheric deposition of metals to concentrations in soils or vegetation have yet to be established and currently there are no Arctic specific soil quality guidelines. Each plant species reacts differently to the amount and frequency of metal uptake or deposition. Presently, in Canada, there are no quality guidelines that have determined toxic concentrations of trace metals in plants; however, trace metal concentrations can be compared over time to assess the effects of mine operations on vegetation.

The Canadian Council of Ministers of the Environment (CCME) have established Canadian soil quality guidelines for the protection of environmental and human health by developing standards for soil quality in Canada (Canadian Council of Ministers of the Environment 2006). These guidelines outline the "*numerical concentrations that are recommended as levels that should result in negligible risk to biota, their functions, or any interactions that are integral to sustaining the health of ecosystems*" (Canadian Council of Ministers of the Environment 2006).

Presently, the U.S. Environmental Protection Agency Ecological Soil Screening Levels (U.S. EPA EcoSSLs) have developed specific screening criteria that are derived to be protective on the exposure of select metals and health effects to vegetation. These criteria are considered on the conservative end. Both the Canadian and U.S. regulatory agencies have derived guidelines that are widely used across North America for determining whether certain metal concentrations in soils merit further consideration.

The assessment of the magnitude of potential metals concentrations in soil outside of the PDA on vegetation health was completed following the same methodology as described in Section 3.2.1.2, Volume 6 of the 2012 FEIS (Baffinland Iron Mines Corporation 2012) and the same prediction of future metal concentrations in soils as a result of Project activities was used.

As stated in the FEIS assessment methods, total estimated future soil concentrations (predicted incremental metal deposition + existing baseline metals in soil) were used to screen for metals based on the U.S. EPA EcoSSLs for the protection of plant health since these measures are considered the most applicable levels for this assessment (Section 3.2.1.2, Volume 6, 2012 FEIS (Baffinland Iron Mines Corporation 2012). They are the most applicable levels because these levels are derived from specific literature pertaining to plant health. The CCME guidelines were used when the U.S. EPA EcoSSLs for certain metals were not available and metals not represented by guidelines from either organization were not considered further.

The magnitude of effects from predicted metal concentration in soil on plant health were determined as follows:

Low: Effects below the soil screening criteria;

Moderate: Effects greater than the soil screening criteria; and

High: Effects that are an order of magnitude greater than soil screening criteria.

Atmospheric Emissions — In 2000, the World Health Organization (WHO) established critical levels of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) emissions based on when detrimental effects on vegetation potentially occur. It was recommended that an air quality guideline of 10 $\mu g/m^3/a$ of SO_2 be established even though annual mean concentrations of 30 $\mu g/m^3$ were associated with the loss of sensitive lichen species (WHO 2000). Unfortunately, it is more difficult to determine critical loads of NO_2 on plants since increasing levels of NO_2 may or may not be beneficial. The WHO recommended a critical level of atmospheric concentrations of NO_2 at approximately 30 $\mu g/m^3$ as an annual mean before detrimental effects can be observed in plants (World Health Organization 2000).

Guidelines associated with nitrogen deposits in soil and vegetation were based on two different sources. Graham et al. (1997) recommends that 5 to 15 N kg/ha/a is a critical load for Arctic and alpine heaths and the WHO (2000) show guidelines for nitrogen deposition to natural systems ranging from 5 to 20 kg/ha/a.

A summary of guidelines demonstrates that critical levels beyond which plant health may be affected are as follows:

- Annual atmospheric concentration of SO_2 ≥ 10 μg/m³/a on lichens;
- Annual atmospheric concentrations of NO_2 ≥ 25 μg/m³/a; and
- Annual deposition of nitrogen ≥ 12 kg N/ha/a.

Based on the best available information, the magnitude of effects of atmospheric emissions are as follows:

Low: < 5 μg/m³/a of SO_2
< 10 μg/m³/a of NO_2
0 – 6 kg N/ha/a of Nitrogen

Moderate: 5 – 10 μg/m³/a of SO_2
10 – 25 μg/m³/a of NO_2
6 – 12 kg N/ha/a of Nitrogen

High: ≥ 10 μg/m³/a of SO_2
≥ 25 μg/m³/a of NO_2
≥ 12 kg N/ha/a of Nitrogen

Included in the Air Quality assessment (TSD 07) was the development of models to predict concentration and deposition patterns of atmospheric particulate matter, SO_2 and NO_2 . From these models, concentration and deposition isopleths were developed at several levels above and below thresholds for effects on plant health.

To estimate the area of each vegetation class affected by annual rates of dust deposition and annual concentration of NO_2 , the resulting isopleths were overlaid on the vegetation class data. The vegetation class data did not include the area of vegetation within the Phase 2 PDA.

Some vegetation classes may be more sensitive than others to dust and emissions. Current literature provides estimates of sensitivity (Table 11) that were applied to the terrestrial vegetation classes identified (FEIS Appendix 6D). These classes are used to assess the potential effects of emissions and dust on vegetation.

Table 11. Vegetation classes predicted to be sensitive to annual TSP deposition, NO_2 emissions, and nitrogen (NO_3) concentration

Vegetation Cover Class (Northern Land Classification, NLC)	Predicted Sensitivity to TSP, NO_2 Emissions and N Deposition	Comments
Wetlands (Emergent sedge and non-tussock sedge associations)	Low	Due to more nutrient rich habitat and diluting effect of water.
Wet sedge – Graminoids and bryoids (Moss association, sedge-moss wet meadow)	High	Grow in acidic habitats with sphagnum that is sensitive to dust (Farmer 1993).
Tussock graminoid tundra (Tussock sedge association)	Low	Generally moist habitat, relatively good growing conditions in moist soils.
Moist to dry non-tussock graminoid/dwarf shrub tundra: 50 – 70% cover (Shrub-sedge tundra)	Moderate	Some low shrub species appear to be sensitive to dust (Walker et al 1985)
Dry graminoid prostrate dwarf shrub tundra: 70 – 100% cover (Dry slopes with forbs, dry cliff ledges)	Moderate	Some low shrub species appear to be sensitive to dust (Walker et al 1985)
Prostrate dwarf shrub – Dryas/heath, usually on bedrock (Heath tundra grading to Dryas-xeric sedge association)	High	Nutrient poor habitats.
Sparsely vegetated bedrock (Lichen-rock associations)	High	Moss, lichen and heath components
Sparsely vegetated till-colluvium	High	Low vegetation cover, nutrient poor.
Bare soil with cryptogam crust – frost boils (Dry slope with forbs, calcerous substrate)	High	Low vegetation cover, nutrient poor.
Barrens (Purple saxifrage barrens, avens and xeric sedge association, Luzula association	High	Extremely sparse vegetation in nutrient poor habitat.

3.3.3 CULTURALLY VALUED VEGETATION

Many traditional and culturally valued plants were identified in previous baseline and assessment reports. In the 2012 FEIS report, only the distribution of a few species that are still regularly used were mentioned. Blueberry was used as an indicator species since its distribution could be modeled. The change in abundance of blueberry plants within the RSA was quantitatively assessed by comparing blueberry abundance before and after Project development using the same methods and assumptions used to assess changes to vegetation abundance.

Based on information collected to date, blueberry abundance within the RSA is very low since approximately 95% of the RSA is classed as having low blueberry cover (0–20%). Any Phase 2 Proposal related effects to culturally valued vegetation will be negligible since blueberry abundance within the RSA is very low and has been previously assessed as being not significant at the RSA scale with a high confidence. No effect assessments for culturally valued vegetation will be completed for Phase 2 Proposal.

3.3.4 CRITERIA FOR ASSESSING SIGNIFICANCE

Significance of the Phase 2 Proposal's potential impact on vegetation is determined in consideration of one or more of the following sources of information (Canter 1999):

- Guidelines or standards outlined in Nunavut or other laws, regulations, policies, etc.
- Pre-defined thresholds
- Setting (e.g., is the Project in protected habitat, critical or sensitive habitat, land-use zone with defined land use thresholds)
- The intensity of the effect (e.g., predicted change, and whether the change is within normal variability); and
- Public concern.

Criteria including direction, magnitude, extent, frequency, reversibility, etc. (described further in Section 3.8 of the assessment methods volume, FEIS Volume 2, Baffinland Iron Mines Corporation (2012b)) are used to characterize the nature of the residual effects. The criteria are assessed in the context of the mitigation measures and Project design features that will be applied to eliminate or reduce the Phase 2 Proposal potential impact(s) on vegetation. Where legislation, thresholds, standards, or objectives exist to define criteria rating and are relevant to the assessment, they are used. Similarly, quantitative values, if available, are used over qualitative criteria.

Guidelines or Standards — There are no guidelines or standards outlined in Nunavut or other laws, regulations, policies, etc. that inform significance criteria or thresholds for vegetation. There are no thresholds of disturbance to vegetation reflected in known Government of Nunavut policy (Government of Nunavut, Department of Executive and Intergovernmental Affairs 2017).

Pre-defined Thresholds — The *North Baffin Land Use Plan* (Nunavut Planning Commission 2000) does not identify any land use disturbance thresholds related to vegetation that are relevant to Project impact significance determination. There are no other sources of pre-defined thresholds that may be relevant to north Baffin Island vegetation.

Setting — e.g., There are no known rare or uncommon vegetation communities identified within the north Baffin Island region. There are no proposed Project terrestrial activities that overlap with national park boundaries.

Public concern — Public concerns related to the Phase 2 Proposal's impacts on vegetation are reflected in Section 3.1. None of the concerns expressed suggested quantifiable significance thresholds.

Where empirical knowledge, IQ, or scientific evidence is lacking, professional judgement and experiences from similar projects were used in determining if a criterion is given more or less weight in assigning impact significance. Any weighting and justification of the weighting are described. After considering the criteria, a confidence rating is determined and applied that considers the accuracy and application of analytical tools, an understanding of the effectiveness of mitigation measures, and an understanding of known responses of vegetation KIs to potential Phase 2 Proposal impacts.

Definitions and rating scales for the criteria for specific vegetation measurable parameters are described in Table 12. The table lists the upper threshold limits that have been proposed for this Project's Vegetation KIs and their respective potential impacts and measurable parameters. There was no new IQ perspective or literature suggesting updates to the thresholds used in the FEIS, so this assessment uses the same threshold levels used for the Approved Project (≤10%, >10–25%, and >25% change; Table 12) for measurable parameters.

Table 12. Potential Effects, Measurable Parameters and Significance Ratings for Vegetation Key Indicators

Effect	Measurable Parameters	Significance Criteria (Magnitude and/or Extent)
Change in Vegetation Abundance and Diversity	NLC classes impacted by Phase 2 Project PDA as a proportion of NLC class available within the RSA	**Level I**: confined to the PDA, or <10% effect on vegetation community available in the RSA **Level II**: >10%–25% change of available vegetation in the RSA. **Level III**: >25% change to vegetation available in the RSA
Change in Vegetation Health	Sensitive vegetation NLC classes impacted by Phase 2 Project emissions deposition as a proportion of the NLC class available within the RSA	**Level I**: <10% effect on vegetation community available in the RSA **Level II**: >10%–25% change of available vegetation in the RSA **Level III**: >25% change to vegetation available in the RSA
Loss of Culturally Valued Vegetation	Vegetation NLC classes that contain berry-producing plants impacted by Phase 2 Project emissions deposition as a proportion of the NLC class available within the RSA	**Level I**: <10% effect on vegetation community available in the RSA **Level II**: >10%–25% change of available vegetation in the RSA **Level III**: >25% change to vegetation available in the RSA

3.4 IMPACT ASSESSMENT

Potential effects to vegetation resulting from the Phase 2 Proposal are summarized in Table 13. The focus of the Phase 2 Proposal assessment includes consideration of the impacts of the increased footprint of Milne Port and the Northern Transportation Corridor, and changes in emissions at Milne Port and the Mine Site. The changes in TSP deposition along the Northern Transportation Corridor are also considered.

Table 13. Potential additional effects to vegetation from the Phase 2 Proposal

Project Interaction	Milne Port	Northern Transportation Corridor	Mine Site
Loss to Footprint	Yes	Yes	No
Change from Emissions Deposition	Yes	Yes (TSP)	Yes
Change from introduction of invasive plant species	No	No	No

3.4.1 VEGETATION ABUNDANCE AND DIVERSITY

The Phase 2 Proposal can affect vegetation abundance and diversity through additional footprint loss, and additional effect on adjacent vegetation due to emissions and deposition. Given that many of the Project components already exist, loss of vegetation due to new infrastructure will be limited to the Northern Transportation Corridor and expansion of the Milne Inlet Port (Table 14).

Construction of the Northern Railway, realignments to the Tote Road and expansion at Milne Port will remove approximately 14.73 km^2 of terrestrial habitat (Table 14). Surface disturbance has already occurred at Milne Port (2.74 km^2), Tote Road (19 km^2) and Mine Site (28 km^2) because of previously approved activities. A conservative approach was used in the assessment by assuming that the entire PDA will be cleared during construction and operations phases. It is also assumed that reclamation will likely be delayed due to Arctic growing conditions.

Table 14. Summary of Predicted Loss of Terrestrial Habitat within the PDA

Project Component	Approved Project (km^2)	Phase 2 (km^2)	Change in PDA from Approved to Phase 2	Potential Direct Loss of Vegetation
Milne Inlet Port	2.74	4.11	+1.37 km^2	Additional loss to existing footprint due to construction of Phase 2 related facilities.
Northern Railway	0	13.10	+13.10 km^2	Additional loss to existing footprint due to construction of the railway
Tote Road	8.65	8.91	+0.26 km^2	Additional loss of existing footprint due to construction of Phase 2 realignments.

There will be a loss of vegetation cover classes (plant communities) because of disturbances within the PDA, but the activities associated with the Phase 2 Proposal will affect the same plant communities as the cover classes presented in the FEIS (Table 15). All plant communities are found within the RSA which signifies that these communities will likely still be present during the mine operations and closure.

A comparison of the representation of plant communities within the Baseline RSA and within the approved PDA indicates that, in general, the activities associated with the Phase 2 Proposal have a similar habitat loss effect on vegetation cover classes as those associated with the approved Project area (Table 15).

Table 15. Predicted Loss of Vegetation Cover Classes because of Disturbance within the PDA

RSA Vegetation Cover Classes	Baseline RSA		Approved Project		Phase 2 Changes			Total Phase 2 Proposal	
	Area (km²)	% RSA	Area (km²)	% of cover in RSA	Area (km²)	% of cover in RSA	% change relative to Approved Project	Area (km²)	% of cover in RSA
Wetlands	214.21	1.0	1.7	0.79	0.03	0.02	1.91	1.73	0.81
Wet sedge – Graminoids and Bryoids	503.85	2.39	3.98	0.79	0.68	0.13	17.02	4.66	0.92
Tussock graminoid tundra	880.28	4.18	4.5	0.51	2.04	0.23	45.33	6.54	0.74
Moist to dry non-tussock graminoid/dwarf shrub tundra: 50 – 70% cover	1,584.17	7.52	8.65	0.55	0.32	0.02	3.67	8.97	0.57
Dry graminoid prostrate dwarf shrub tundra: 70 – 100% cover	4.76	0.02	0.01	0.21	0.01	0.10	50.00	0.02	0.31
Prostrate dwarf shrub – Dryas/heath, usually on bedrock	3,498.41	16.62	17.25	0.49	1.28	0.04	7.41	18.53	0.53
Sparsely vegetated bedrock	5,899.23	28.02	19.55	0.33	0.72	0.01	3.68	20.27	0.34
Sparsely vegetated till-colluvium	2,049.17	9.73	9.41	0.46	2.77	0.14	29.44	12.183	0.59
Bare soil with cryptogam crust – frost boils	2,116.15	10.05	17.10	0.81	3.93	0.19	22.95	21.03	0.99
Barrens	1,681.07	7.98	2.06	0.12	2.34	0.14	113.47	4.40	0.26
Water/Ice/Snow/ Unclassified	2,622.72	12.46	2.89	0.11	0.34	0.02	11.85	3.23	0.17

There are several vegetation cover classes in which the Phase 2 Proposal will involve a proportionally large increase in the disturbance areas, in the order of 1.5 to 2x, when measured relative to the disturbance area of the Approved Project. The total areas affected by the Phase 2 Proposal are still a small proportion available in the RSA.

As previously discussed, loss of vegetation abundance and diversity may occur from dust deposition and emissions deposition in areas adjacent the PDA. The effects of dust and emissions on vegetation abundance and diversity will be assessed in the vegetation health section below. Currently, based on monitoring program results, no recognized invasive plant species have been detected within the RSA. Baffinland intends to continue to mitigate this potential effect by ensuring that all equipment brought to the Project site has been cleaned of soils that could contain plant seeds that do not currently occur with the RSA and to continue to allow natural regeneration of disturbed areas.

The following mitigation measures will be implemented:

- Project activities will be planned and conducted to minimize the Project footprint within the PDA;
- Re-vegetation of the terrestrial habitat will be allowed to occur naturally, unless the vegetation monitoring program (progressive rehabilitation studies) determines that re-seeding with native species is required and can be completed without the introduction of invasive plant species; and
- Any equipment brought to the Project site will be cleaned of soils that could contain plant seeds that do not naturally occur in the RSA. This mitigation measure will reduce the likelihood of invasive plant species becoming establish within the RSA due to Project development activities.

3.4.2 VEGETATION HEALTH

Dust (TSP) — For the Phase 2 Proposal, dust will be generated at Milne Inlet, along the Tote Road, the Mine Site, and along the proposed railway. The air quality assessment (TSD 07) identified the predicted dust deposition rates from the point sources and along the transportation corridor. Mitigation of dust effects on vegetation are addressed by those measures used to mitigate effects on air quality as described in the Approved Project's FEIS Volume 5, Section 2.

Fugitive dust emissions along the Tote Road will increase temporarily (for potentially 2 years) as Baffinland increases the road haulage of ore up to 6 Mtpa. Once the North Railway is operational, truck haulage of ore will cease and the level of traffic on the road will decrease substantially, as will the corresponding fugitive dust emissions along the road. A total of 1,068 km² of vegetated habitat has the potential to be exposed to some level of dust deposition from all Phase 2 Proposed Activities.

The largest area affected will be along the Tote Road, followed by the Mine Site and then the North Railway. Plant health may be affected in an additional 85 km² of vegetated habitat surrounding the Tote Road (outside of the PDA), where the TSP threshold of > 50 g/m²/a will be exceeded as a result of Phase 2 activities (Table 16; Map 9). Activities associated with the Phase 2 Proposal do slightly exceed the High threshold outside of the PDA at the Milne Port (additional 2 km²) and the Mine Site (additional 5 km²) more than what was already assessed for the Approved Project (Table 16). The use of the North Railway will exceed the High threshold in 14 km² of the terrestrial habitat outside of the PDA that was not a part of the Approved Project.

There is a slight increase in TSP in the high dustfall area along the Tote Road during the temporary increase in road haulage (Table 17). During this same time, there is a decrease in TSP in the high dustfall area at the Milne Port and Mine Site (Table 17). Overall, there are no changes in the terrestrial area affected by annual TSP outside of PDA during the period estimated as having an increase in fugitive dust and the period when the North Railway will be operational.

Table 16. The area (km²) outside of the PDA affected by annual dust (TSP) deposition by project location on vegetation cover units

Project Location	Low (0–4.6 g/m²/a)		Moderate (4.6–50 g/m²/a)		High (> 50 g/m²/a)		Terrestrial Area (km²) Outside of PDA Affected by Annual TSP		
	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Phase 2 Total
Milne Port	19.5	-4.3	8.6	-0.8	0	2	28.1	-3	25.0
Tote Road	81.1	303.7	57.3	172.2	2	85	140.1	561	701.3
North Railway	2.9	8.5	0	25.2	0	14	2.9	48	50.9
Mine Site	199.5	4.4	72.1	8.7	5	10	276.5	23	299.3
Total	303	312.3	138	205.3	6.7	111.2	447.6	628.7	1,076.4

Table 17. The area (km²) outside of the PDA affected by annual dust (TSP) deposition by project location on vegetation cover units during maximum road haulage

Project Location	Low (0–4.6 g/m²/a)		Moderate (4.6–50 g/m²/a)		High (> 50 g/m²/a)		Terrestrial Area (km²) Outside of PDA Affected by Annual TSP		
	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Phase 2 Total
Milne Port	19.5	-4.3	8.6	-1.5	0	10	28.1	-5	23.6
Tote Road	81.1	303.9	57.3	174.4	2	94	140.1	572	712.2
North Railway	2.9	8.3	0	23.4	0	8	2.9	40	42.5
Mine Site	199.5	4.4	72.1	8.8	5	8	276.5	22	298.1
Total	303	312.3	138	205.2	6.7	111.3	447.6	628.7	1,076.4

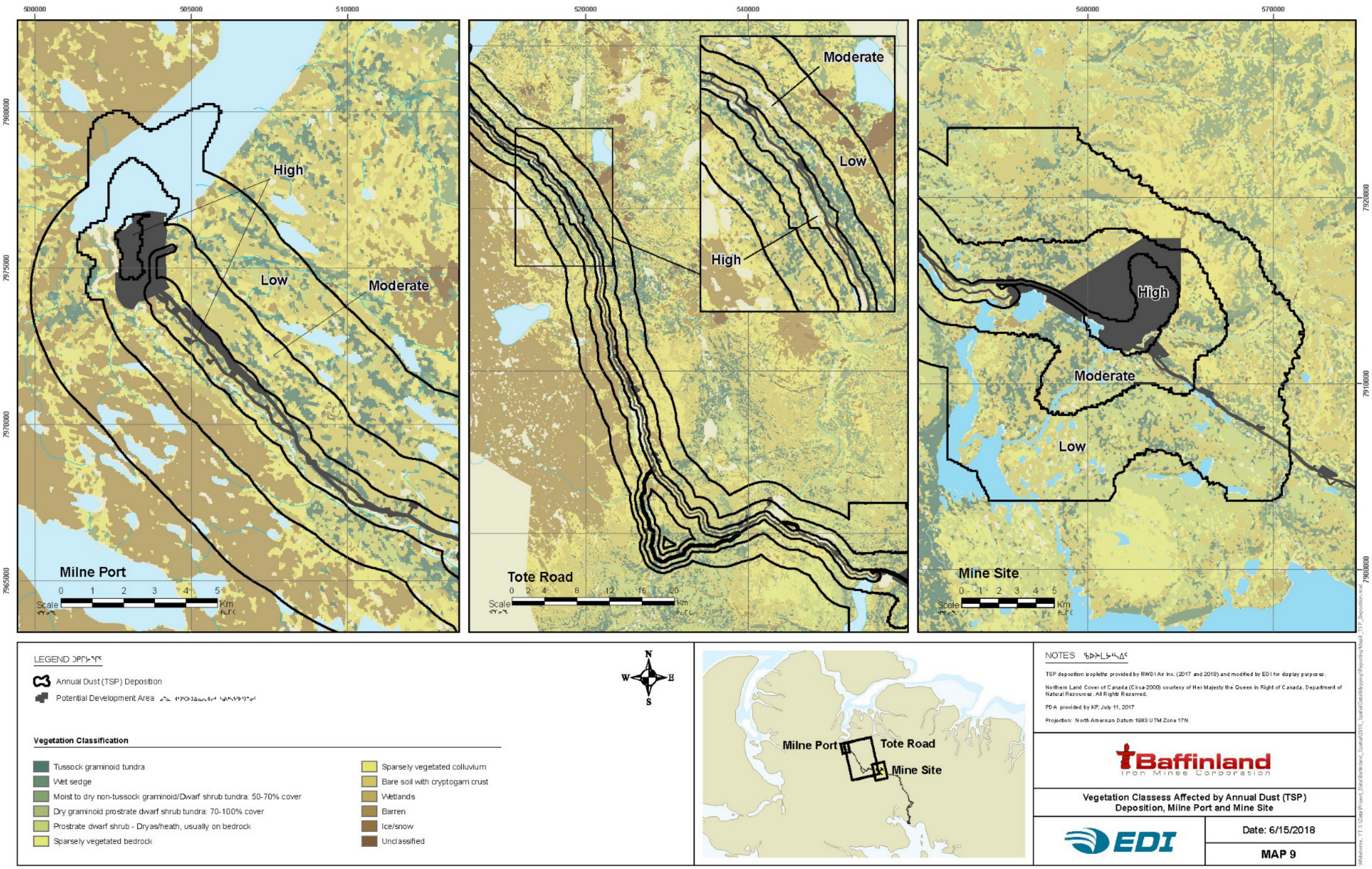
All vegetation cover classes are affected by annual TSP deposition outside of the PDA with effects limited to 0.7 to 14.3% (Approved+Phase 2) of the vegetation class available in the RSA (Table 18). Phase 2 Proposal TSP deposition outside of the PDA effects are limited to 0.3 to 9.0% of the vegetation classes available in the RSA with the greatest affect to Bare soil with cryptogam crust-frost boils vegetation class (Table 18) which is a vegetation class that may be sensitive to TSP deposition.

Overall, there are no changes in the RSA vegetation cover classes affected by TSP outside of PDA during the period estimated as having an increase in fugitive dust when up to 12 Mtpa is being hauled on the road and the North Railway is becoming fully operational (Table 19).

All vegetation classes considered sensitive to dust deposition will be affected by annual TSP deposition outside of the PDA, and most of the habits will remain intact within the RSA. As previously mentioned the vegetation class with the greatest proportion potentially experiencing dustfall is the bare soil with cryptogam crust-frost boils vegetation class where overall 14.3% of the available cover in the RSA is subject to dustfall and 34.4 km² is subject to the High threshold where effects may be detected. Some of the more sensitive communities may experience the following effects: reduced biomass, changes in community composition, or declined in growth. Because of earlier snow melt due to dust deposition, all vegetation communities may experience earlier green-up. The extent of areas experiencing earlier snow melt is currently unknown and considered unpredictable.

The following mitigation measures and project design features will continue to reduce fugitive dust emissions:

- Ongoing dust suppression – additional water takes were identified in 2017 and are in use
- Secondary ore crushing and screening will be moved to Milne Port and enclosed
- The transition from road to rail as the primary mode of haulage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High
Low
Moderate
Milne Port
Tote Road
Mine Site
Scale
Km
LEGEND
Annual Dust (TSP) Deposition
Potential Development Area
Vegetation Classification
Tussock graminoid tundra
Wet sedge
Moist to dry non-tussock graminoid/Dwarf shrub tundra: 50-70% cover
Dry graminoid prostrate dwarf shrub tundra: 70-100% cover
Prostrate dwarf shrub - Dryas/heath, usually on bedrock
Sparsely vegetated bedrock
Sparsely vegetated colluvium
Bare soil with cryptogam crust
Wetlands
Barren
Ice/snow
Unclassified
N
W
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NOTES
TSP deposition isopleths provided by RWDI Air Inc. (2017 and 2018) and modified by EDI for display purposes.
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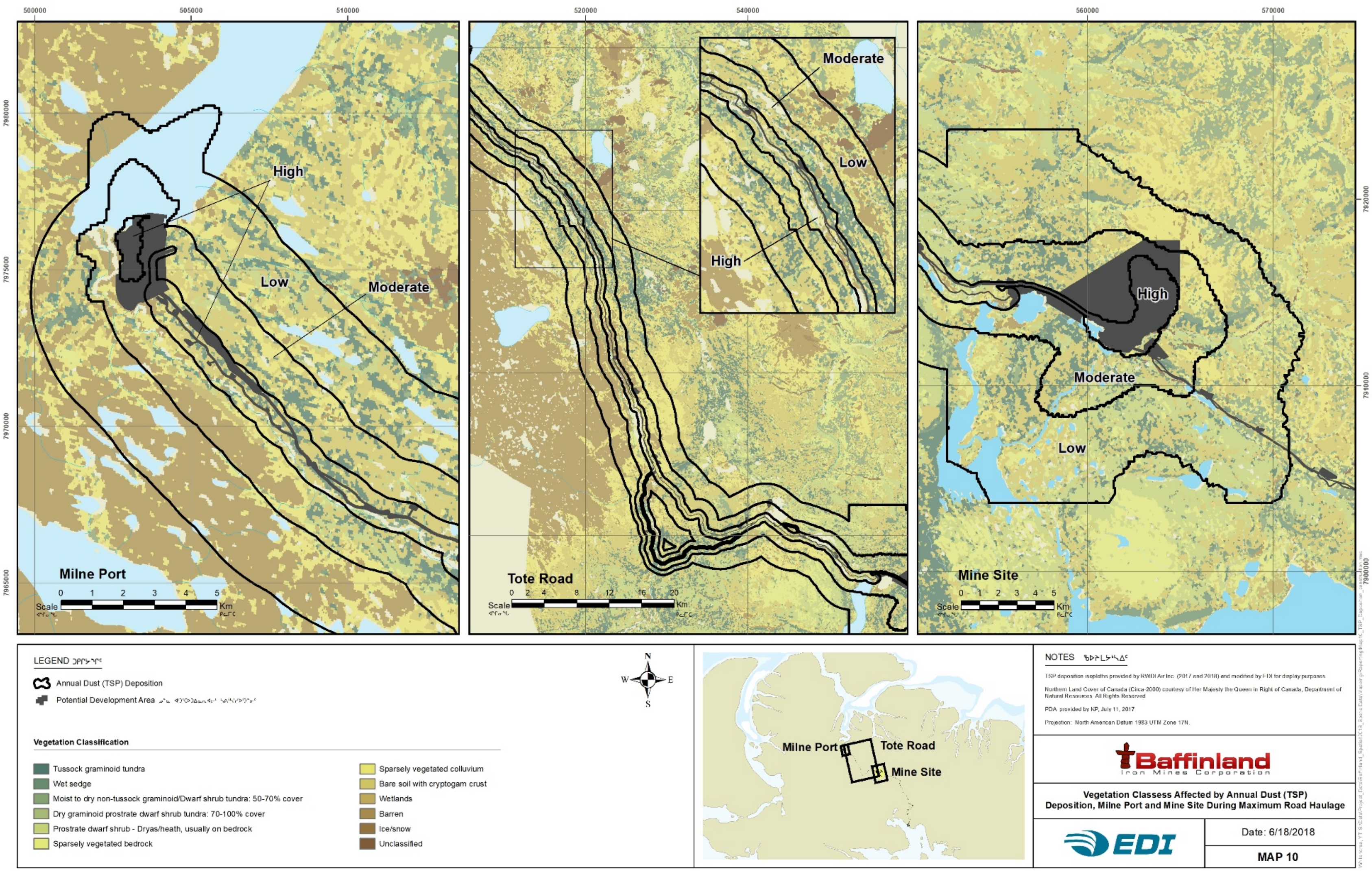
Projection: North American Datum 1983 UTM Zone 17N.
Baffinland
Iron Mines Corporation
Vegetation Classess Affected by Annual Dust (TSP) Deposition, Milne Port and Mine Site
EDI
Date: 6/15/2018
MAP 9



Milne Port
Tote Road
Mine Site
High
Moderate
Low
Scale
Km
LEGEND
Annual Dust (TSP) Deposition
Potential Development Area
Vegetation Classification
Tussock graminoid tundra
Wet sedge
Moist to dry non-tussock graminoid/Dwarf shrub tundra: 50-70% cover
Dry graminoid prostrate dwarf shrub tundra: 70-100% cover
Prostrate dwarf shrub - Dryas/heath, usually on bedrock
Sparsely vegetated bedrock
Sparsely vegetated colluvium
Bare soil with cryptogam crust
Wetlands
Barren
Ice/snow
Unclassified
NOTES
TSP deposition isopleths provided by RWDI Air Inc. (2017 and 2018) and modified by EDI for display purposes
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PDA provided by KP, July 11, 2017
Projection: North American Datum 1983 UTM Zone 17N.
Baffinland
Iron Mines Corporation
Vegetation Classess Affected by Annual Dust (TSP) Deposition, Milne Port and Mine Site During Maximum Road Haulage
EDI
Date: 6/18/2018
MAP 10

Table 18. Vegetation cover classes affected by annual dust (TSP) deposition

RSA Vegetation Cover Classes	Baseline RSA Area		Area (km²) affected by Annual Dust (TSP) Deposition outside of the PDA						RSA affected by TSP outside of the PDA					
			Low (<4.6 g/m²/a)		Moderate (4.6-50 g/m²/a)		High (>50 g/m²/a)		Area (km²)			% of vegetation cover class in RSA		
	Area (km²)	% RSA	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Phase 2 Total	Approved	+ Phase 2	Phase 2 Total
Wetlands	214	1.0	2.1	2.5	1.1	2.9	0	0.8	3.2	6.2	9.4	1.5	2.9	4.4
Wet sedge – Graminoids and Bryoids	504	2.4	11.8	4.3	6.4	3.5	0.2	3.4	18.4	11.2	29.6	3.7	2.2	5.9
Tussock graminoid tundra	880	4.2	28.7	29.4	17.1	27.7	0.6	13.3	46.4	70.5	116.9	5.3	8.0	13.3
Moist to dry non-tussock graminoid/ dwarf shrub tundra: 50 – 70% cover	1,585	7.5	21.7	7.1	6	3.0	0.4	2.5	28.1	12.6	40.7	1.8	0.8	2.6
Dry graminoid prostrate dwarf shrub tundra: 70 – 100% cover	5	< 1	0.2	0.1	0.1	-0.1	0	0.0	0.3	0.0	0.3	6.0	0.4	6.5
Prostrate dwarf shrub – Dryas/heath, usually on bedrock	3,499	16.6	45.1	35.5	13.7	14.6	0.2	7.7	59	57.7	116.7	1.7	1.7	3.3
Sparsely vegetated bedrock	5,901	28.0	22	8.0	5.8	3.2	0.2	4.9	28	16.0	44.0	0.5	0.3	0.7
Sparsely vegetated till-colluvium	2,050	9.7	40.8	76.0	11.4	57.9	0.5	21.9	52.7	155.8	208.5	2.6	7.6	10.2
Bare soil with cryptogam crust – frost boils	2,116	10.1	78.8	86.0	30.7	70.6	1.6	34.4	111.1	191.0	302.1	5.3	9.0	14.3
Barrens	1,681	8.0	18.8	58.9	7.4	36.6	0.1	12.8	26.3	108.2	134.5	1.6	6.4	8.0
Water/Ice/Snow/ Unclassified	2,618	12.4	19.1	12.7	12.8	8.6	1.2	11.3	33.1	32.6	65.7	1.3	1.2	2.5
Total (Baseline RSA total area includes areas not classified)	21,053	100	289.1	320.3	112.5	228.5	5	112.9	406.6	661.8	1,068.4	2.0	3.2	5.2

Note:

Predicted high sensitivity to TSP vegetation classes (Table 11) are highlighted in grey

Table 19. Vegetation cover classes affected by annual dust (TSP) deposition during maximum road haulage

RSA Vegetation Cover Classes	Baseline RSA Area		Area (km²) affected by Annual Dust (TSP) Deposition outside of the PDA						RSA affected by TSP outside of the PDA					
	Area (km²)	% RSA	Low (<4.6 g/m²/a)		Moderate (4.6-50 g/m²/a)		High (>50 g/m²/a)		Area (km²)			% of vegetation cover class in RSA		
			Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Phase 2 Total	Approved	+ Phase 2	Phase 2 Total
Wetlands	214	1.0	2.1	2.5	1.1	2.9	0	0.8	3.2	6.2	9.4	1.5	2.9	4.4
Wet sedge – Graminoids and Bryoids	504	2.4	11.8	4.3	6.4	3.5	0.2	3.4	18.4	11.2	29.6	3.7	2.2	5.9
Tussock graminoid tundra	880	4.2	28.7	29.4	17.1	27.7	0.6	13.4	46.4	70.5	116.9	5.3	8.0	13.3
Moist to dry non-tussock graminoid/ dwarf shrub tundra: 50 – 70% cover	1,585	7.5	21.7	7.1	6	3.0	0.4	2.5	28.1	12.6	40.7	1.8	0.8	2.6
Dry graminoid prostrate dwarf shrub tundra: 70 – 100% cover	5	< 1	0.2	0.1	0.1	-0.1	0	0	0.3	0	0.3	6.0	0.4	6.5
Prostrate dwarf shrub – Dryas/heath, usually on bedrock	3,499	16.6	45.1	35.5	13.7	14.6	0.2	7.7	59	57.7	116.7	1.7	1.7	3.3
Sparsely vegetated bedrock	5,901	28.0	22	8.0	5.8	3.2	0.2	4.9	28	16.0	44.0	0.5	0.3	0.7
Sparsely vegetated till-colluvium	2,050	9.7	40.8	76.0	11.4	57.9	0.5	21.9	52.7	155.8	208.5	2.6	7.6	10.2
Bare soil with cryptogam crust – frost boils	2,116	10.1	78.8	86.0	30.7	70.5	1.6	34.5	111.1	191.0	302.1	5.3	9.0	14.3
Barrens	1,681	8.0	18.8	58.9	7.4	36.6	0.1	12.8	26.3	108.2	134.5	1.6	6.4	8.0
Water/Ice/Snow/ Unclassified	2,618	12.4	19.1	12.7	12.8	8.9	1.2	11.3	33.1	32.9	66.0	1.3	1.3	2.5
Total (Baseline RSA total area includes areas not classified)	21,053	100	289.1	320.3	112.5	228.7	5	113.1	406.6	662.1	1,068.7	2.0	3.2	5.2

Note:

Predicted high sensitivity to TSP vegetation classes (Table 11) are highlighted in grey

Metals in Dust — Most of the dust (TSP) is expected to be generated from the mining, crushing, hauling and stockpiling of ore. The ore associated with this mining is largely composed of iron with several trace metals. There is the potential that dust released during Project activities could contain metals and these metals will persist in the environment once released. There are no changes to the metals composition of the dust for Phase 2 Proposal activities.

A portion of emitted dust is expected to settle in areas outside of the PDA. Metals in dust that extend beyond the PDA will add to naturally occurring metals in soils and have the potential to be taken up by vegetation via the roots.

It is expected that Phase 2 Proposal activities will not contribute to any increase in metals in dust because no activities are associated with the Mine Site or Steensby Port. It is assumed that the total predicted soil metal concentration will not change from the analysis completed in the 2012 FEIS (Table 20). The Phase 2 Proposal will not contribute to a negative effect on vegetation health because there is no predicted change to soil metal concentrations from dust. The Phase 2 Proposal effect of metals in dust on vegetation health is considered a neutral effect and its significance will not be further assessed.

Table 20. Total predicted soil metal concentration in comparison to U.S. EPA EcoSSLs and CCME Soil Guidelines assuming 120 g TSP/m²/a deposition rate

Metal	Total Predicted Future Soil Metals Concentration (mg/kg)	U.S. EPA EcoSSLs (mg/kg)	CCME Soil Criteria for Agricultural Land Use (mg/kg)	Predicted High, Moderate, Low Magnitude Effect
Aluminium	19,500	[1]		Low
Arsenic	121	18	12	High
Barium	73.3		750	Low
Cadmium	1.52	32	1.4	Low
Cobalt	17.4	13		Moderate
Chromium	90.9		64	Moderate
Copper	77.5	70	63	Moderate
Iron	127,000	[2]		Low
Lead	31.9	120	70	Low
Manganese	4 330	220		High
Nickel	60.5	38	50	Moderate
Selenium	2.17	0.52	1	Moderate
Silver	1.48	560		Low
Thallium	0.303		1	Low

Table 20. Total predicted soil metal concentration in comparison to U.S. EPA EcoSSLs and CCME Soil Guidelines assuming 120 g TSP/m²/a deposition rate

Metal	Total Predicted Future Soil Metals Concentration (mg/kg)	U.S. EPA EcoSSLs (mg/kg)	CCME Soil Criteria for Agricultural Land Use (mg/kg)	Predicted High, Moderate, Low Magnitude Effect
Uranium	5.99		23	Low
Vanadium	63.6		130	Low
Zinc	93.5	160	200	Low

Note(s):

1. U.S. EPA (2003a) reports that total or available aluminium in soils is not a suitable or reliable predictor of toxicity. It is recommended that aluminium only be considered when soil pH is <5.5 since aluminium solubility (which determines bioavailability to plants) is pH dependent, based on limited baseline soil pH data that was collected within the various project study areas, soil pH is in the slightly acidic to neutral range (6–7.5). Therefore, aluminium does not merit further study.
2. U.S. EPA (2003b) reports that identifying a specific benchmark for iron in soils is difficult since iron's bioavailability to plants and the resulting potential toxicity are dependent upon site specific soil conditions such as pH and moisture. The U.S. EPA recommends that the site-specific measured pH be used in part to determine the expected valence state of iron and associated chemical compounds, and the resulting bioavailability and potential toxicity in the study location. In well-aerated soils between pH 5 and 8, the iron demand of plants is higher than the amount available. Thus, plants have evolved various mechanisms to enhance iron uptake. Soil pH in baseline soils was in the 6 to 7.5 pH range and therefore is slightly acidic to neutral. This indicated that iron would not likely be of concern to terrestrial plants.

Atmospheric Emissions — The 2012 FEIS stated that the largest terrestrial area experiencing nitrogen dioxide emissions (outside of the PDA) is at Milne Port, followed by the Mine Site. The high threshold of ≥ 25 µg NO_2 /m³/a is exceeded in a 0.02 km² area outside of the PDA at Milne Port. The area experiencing the high threshold is reduced by 2.5 km² because of changes in emissions at the mine site for the Phase 2 Proposal (Table 21; Map 11).

All vegetation classes are present in each of the areas affected by NO_2 , but no vegetation classes are disproportionally affected by NO_2 emissions outside of the PDA (Table 22). Overall 2.3% of the RSA is affected by NO_2 emissions. The range of effects on individual vegetation cover classes ranges from 0.3 to 6.8% of individual vegetation cover class availability throughout the RSA (Table 22). The greatest effects are predicted to be on the more sensitive vegetation cover classes, including Barrens (6.8%) and Bare soil with cryptogam crust – frost boils (5.2%). Mitigation of emissions on vegetation will be addressed by measures implemented to mitigate effects on air quality described in the Air Quality and Noise Abatement Management Plan (Baffinland Iron Mines Corporation 2016*b*).

For nitrogen deposition, Phase 2 Proposal activities will affect an additional 12.2 km², but none of that additional area exceeds the estimated moderate or high thresholds (Table 23; Map 12). No vegetation cover classes outside of the PDA will experience nitrogen deposition above high threshold values (Table 24).

The effects of nitrogen deposition may be negligible and undetectable. No additional mitigations to address effects to vegetation by nitrogen deposition are recommended for the Phase 2 Proposal.

Like results presented for the Approved Project, SO_2 emissions were below the lowest threshold (Max: 1.48 µg/m³/a), and emissions are expected to be limited to a 1.8 km² area outside of the PDA around the Mine Site (Addendum to the FEIS) and is therefore not considered further.

Table 21. The area outside of the PDA affected by atmospheric nitrogen dioxide (NO_2) emissions

Project Location	Area (km²) Affected by Annual Nitrogen Dioxide Emissions						Total Terrestrial Area Outside of PDA Affected by Annual NO_2 (km²)		
	Low (≤10 µg/m³/a)		Moderate (10 – 25 µg/m³/a)		High (≥25 µg/m³/a)				
	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Total Phase 2 Proposal
Milne Port	118.3	147.7	4.9	13.3	0	0.02	123.2	161.0	284.2
Mine Site	nd[1]	214.10	9.8	-2.0	2.7	-2.5	12.5	-4.4	222.2
Total	118.3	147.7	14.7	11.3	2.7	-2.5	135.7	156.6	506.4

1. No data (nd): Low threshold for Nitrogen Dioxide emissions were not mapped or calculated for the Approved Project

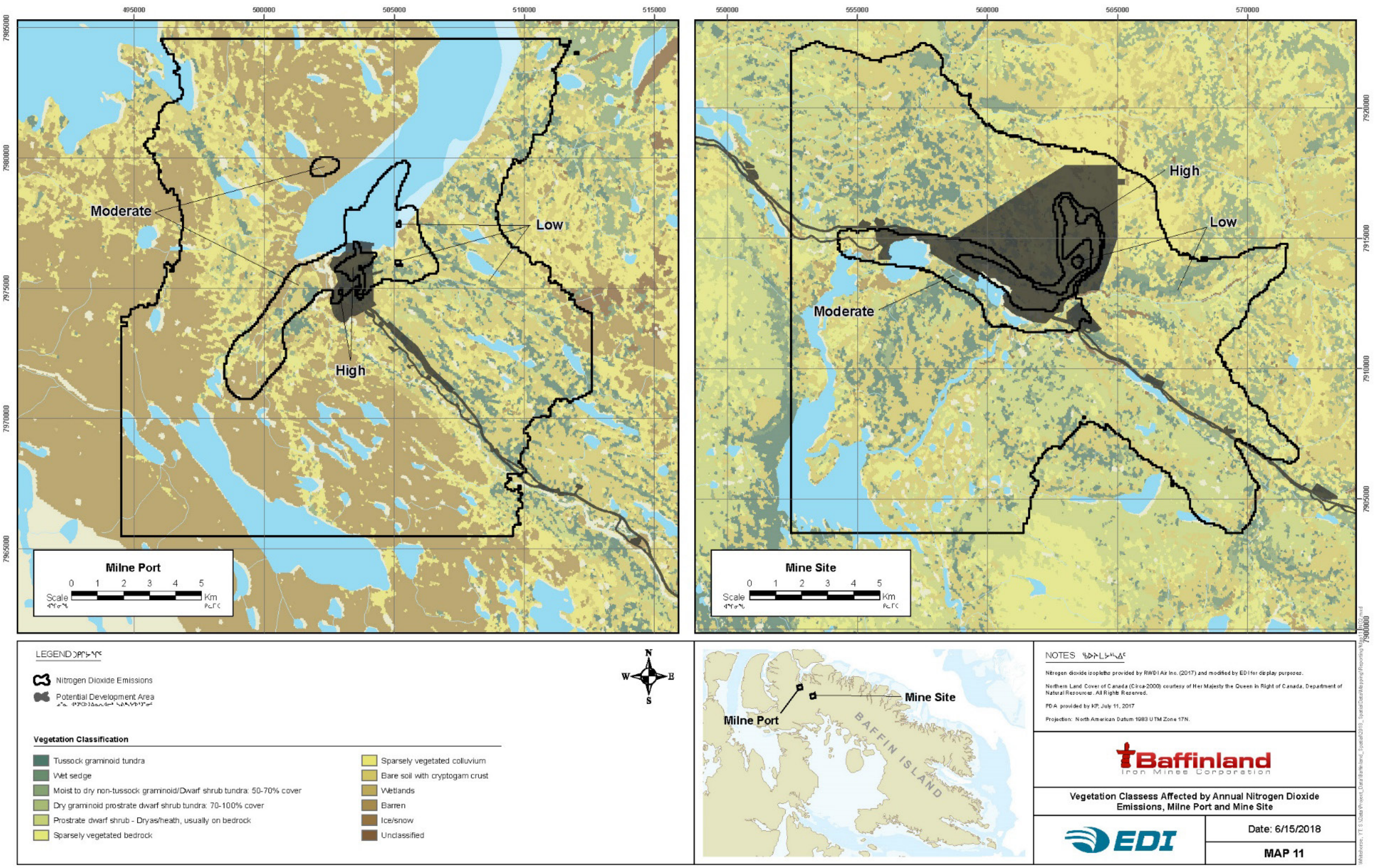
Moderate
Low
High
Milne Port
Scale
Km
Mine Site
LEGEND
Nitrogen Dioxide Emissions
Potential Development Area
Vegetation Classification
Tussock graminoid tundra
Wet sedge
Moist to dry non-tussock graminoid/Dwarf shrub tundra: 50-70% cover
Dry graminoid prostrate dwarf shrub tundra: 70-100% cover
Prostrate dwarf shrub - Dryas/heath, usually on bedrock
Sparsely vegetated bedrock
Sparsely vegetated colluvium
Bare soil with cryptogam crust
Wetlands
Barren
Ice/snow
Unclassified
BAFFIN ISLAND
NOTES
Nitrogen dioxide isopleths provided by RWDI Air Inc. (2017) and modified by EDI for display purposes.
Northern Land Cover of Canada (Circa-2000) courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.
PDA provided by KP, July 11, 2017
Projection: North American Datum 1983 UTM Zone 17N.
Baffinland
Iron Mines Corporation
Vegetation Classess Affected by Annual Nitrogen Dioxide Emissions, Milne Port and Mine Site
EDI
Date: 6/15/2018
MAP 11

Table 22. Vegetation cover classes outside the PDA affected by atmospheric nitrogen dioxide (NO_2) emissions

RSA Vegetation Cover Classes	Baseline RSA Area		Area (km²) affected by NO_2 emissions						RSA affected by NO_2 emissions				
	Area (km²)	% RSA	Low (≤10 µg/m³/a)		Moderate (10 – 25 µg/m³/a)		High (≥25 µg/m³/a)		Area (km²)			% vegetation cover class of RSA	
			Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Phase 2 Total	Approved	Phase 2 Total
Wetlands	214	1.0	1.4	1.3	0.1	0.1	0.0	0.0	1.5	1.4	2.9	0.7	1.4
Wet sedge – Graminoids and Bryoids	504	2.4	2.8	9.3	0.8	-0.2	0.1	-0.1	3.7	8.9	12.6	0.7	2.5
Tussock graminoid tundra	880	4.2	4.8	32.0	2.5	-0.2	0.4	-0.4	7.7	31.5	39.2	0.9	4.5
Moist to dry non-tussock graminoid/dwarf shrub tundra: 50 – 70% cover	1,585	7.5	2.7	12.6	0.8	0.0	0.2	-0.2	3.7	12.4	16.1	0.2	1.0
Dry graminoid prostrate dwarf shrub tundra: 70 – 100% cover	5	< 1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.2	2.0	3.8
Prostrate dwarf shrub – Dryas/heath, usually on bedrock	3,499	16.6	2.2	48.6	1.4	-0.9	0.1	-0.1	3.7	47.6	51.3	0.1	1.5
Sparsely vegetated bedrock	5,901	28.0	1.7	16.5	0.3	-0.1	0.1	-0.1	2.1	16.4	18.5	0.0	0.3
Sparsely vegetated till-colluvium	2,050	9.7	16.4	45.3	1.5	2.1	0.2	-0.2	18.1	47.2	65.3	0.9	3.2
Bare soil with cryptogam crust – frost boils	2,116	10.0	14.6	90.1	3.5	1.0	0.5	-0.5	18.6	90.7	109.3	0.9	5.2
Barrens	1,681	8.0	45.2	63.5	1.4	3.8	0.1	-0.1	46.7	67.1	113.8	2.8	6.8
Water/Ice/Snow/Unclassified	2,618	12.5	26.5	21.6	2.4	1.4	1.0	-0.8	29.9	22.2	52.1	1.1	2.0
Total (Baseline RSA total area includes areas not classified)	21,053	100	118.4	340.9	14.7	7.0	2.7	-2.5	135.8	345.4	481.2	0.7	2.3

Table 23. Area outside the PDA affected by nitrogen (N) deposition

Project Location	Area (km^2) Affected by Nitrogen Deposition								
	Low (≤6 kg N/ha/a)		Moderate (6 – 12 kg N/ha/a)		High (≥12 kg N/ha/a)		Total Terrestrial Area Outside of PDA Affected by Annual N Deposition		
	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Phase 2 Total
Milne Port	0.1	8.0	0.0	0.0	0.0	0.0	0.1	8.0	8.1
Mine Site	0.0	4.6	0.4	-0.4	0.0	0.0	0.4	4.2	4.6
Total	0.1	12.6	0.4	-0.4	0.0	0.0	0.5	12.2	12.7

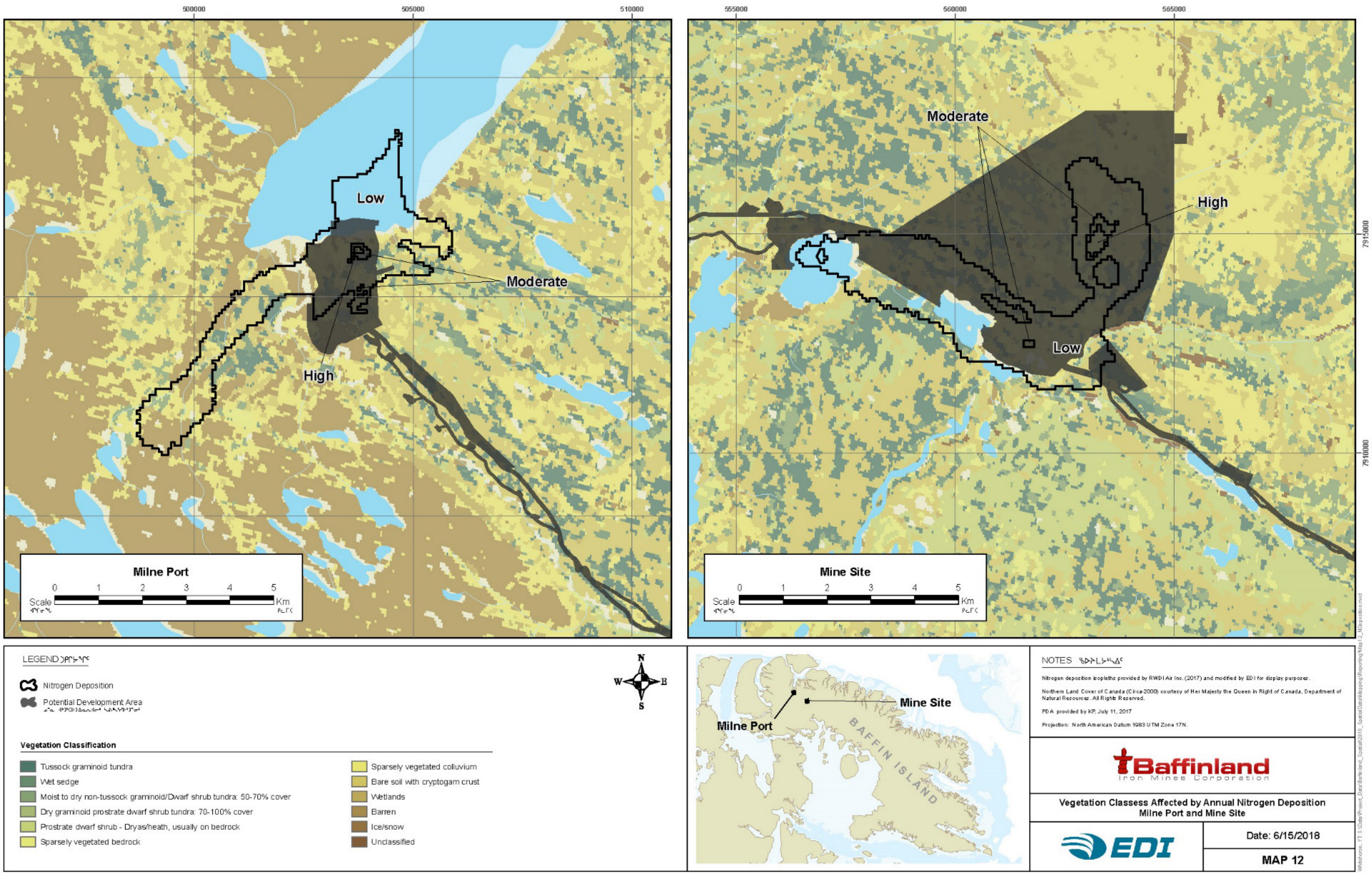
Low
Moderate
High
Milne Port
Scale
Km
0 1 2 3 4 5
Mine Site
LEGEND
Nitrogen Deposition
Potential Development Area
Vegetation Classification
Tussock graminoid tundra
Wet sedge
Moist to dry non-tussock graminoid/Dwarf shrub tundra: 50-70% cover
Dry graminoid prostrate dwarf shrub tundra: 70-100% cover
Prostrate dwarf shrub - Dryas/heath, usually on bedrock
Sparsely vegetated bedrock
Sparsely vegetated colluvium
Bare soil with cryptogam crust
Wetlands
Barren
Ice/snow
Unclassified
BAFFIN ISLAND
NOTES
Nitrogen deposition isopleths provided by RWDI Air Inc. (2017) and modified by EDI for display purposes.
Northern Land Cover of Canada (Circa-2000) courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.
PDA provided by KP, July 11, 2017
Projection: North American Datum 1983 UTM Zone 17N.
Baffinland Iron Mines Corporation
Vegetation Classess Affected by Annual Nitrogen Deposition
Milne Port and Mine Site
EDI
Date: 6/15/2018
MAP 12

Table 24. Vegetation cover classes outside of the PDA affected by atmospheric nitrogen (N) deposition

RSA Vegetation Cover Classes	Baseline RSA		Area (km²) affected by Nitrogen Deposition						RSA affected by Nitrogen Deposition				
	Area (km²)	% RSA	Low (≤6 kg N/ha/a)		Moderate (6 – 12 kg N/ha/a)		High (≥12 kg N/ha/a)		Area (km²)			% class of RSA	
			Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Approved	+ Phase 2	Phase 2 Total	Approved	Phase 2 Total
Wetlands	214	1.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Wet sedge – Graminoids and Bryoids	504	2.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0
Tussock graminoid tundra	880	4.2	0.01	1.5	0.0	0.0	0.0	0.0	0.01	1.5	1.5	0.001	0.2
Moist to dry non-tussock graminoid/dwarf shrub tundra: 50 – 70% cover	1,585	7.5	0.0	0.4	0.01	-0.01	0.0	0.0	0.01	0.4	0.4	0.001	0.0
Dry graminoid prostrate dwarf shrub tundra: 70 – 100% cover	5	< 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prostrate dwarf shrub – Dryas/heath, usually on bedrock	3,499	16.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0
Sparsely vegetated bedrock	5,901	28.0	0.0	0.1	0.02	-0.02	0.0	0.0	0.02	0.1	0.1	0.0003	0.0
Sparsely vegetated till-colluvium	2,050	9.7	0.02	1.7	0.0	0.0	0.0	0.0	0.02	1.7	1.7	0.001	0.1
Bare soil with cryptogam crust – frost boils	2,116	10.0	0.02	2.4	0.0	0.0	0.0	0.0	0.02	2.4	2.4	0.001	0.1
Barrens	1,681	8.0	0.01	1.8	0.0	0.0	0.0	0.0	0.01	1.8	1.9	0.001	0.1
Water/Ice/Snow/Unclassified	2,618	12.5	0.02	2.6	0.3	-0.3	0.0	0.0	0.4	2.3	2.6	0.01	0.1
Total (Baseline RSA total area includes areas not classified)	21,053	100	0.1	11.0	0.4	-0.4	0.0	0.0	0.4	10.6	11.1	0.002	0.1

3.4.3 CULTURALLY VALUED VEGETATION

As previously mentioned, even if the entire Phase 2 Proposal PDA is cleared, the reduction of blueberry cover will be minor and indistinguishable from the baseline conditions at the RSA scale. Furthermore, much of the Milne Port, Tote Road and Mine Site are already disturbed areas, so the reduction of blueberry cover will be small. It is estimated that the blueberry cover loss is likely an overestimate of the true effect.

Mitigations measures identified for reducing effects of the Phase 2 Proposal on vegetation abundance and diversity are considered suitable for mitigating effects to culturally valued vegetation.

3.4.4 SIGNIFICANCE OF RESIDUAL EFFECTS ON VEGETATION

Vegetation Abundance and Diversity — *There is high confidence that the Phase 2 proposal will have a not significant impact on vegetation abundance and diversity.* The additional loss of vegetation within the PDA because of the Phase 2 Proposal is considered a residual effect. Disturbed areas are not expected to become revegetated until the closure of the mine and it is assumed that some sections of the footprint will not return to baseline conditions. The predicted levels of vegetation abundance and diversity effects based on the evaluation criteria are provided in Table 25, and a summary of significance is provided in Table 26.

Vegetation Health — *There is medium confidence that the Phase 2 Proposal will have a not significant impact on vegetation health.* This moderate confidence is because thresholds have not been developed for dust effects on plants, and the literature acknowledges a lack of data for effects of atmospheric emissions on Arctic vegetation. The threshold values are an estimate based the best available information much of which is based on research with little information on Arctic communities. Also, potential effects of metals on plants from aerial deposition are highly dependent on site-specific conditions and the individual plant species. Regardless of this uncertainty, the geographic extent of the impact on vegetation accounts for only a small proportion of the vegetation available in the RSA.

Air quality models have demonstrated that annual dust deposition will occur beyond threshold values outside of the PDA. When air emissions and nitrogen deposition ceases after the closure of the Project, the effects of nitrogen additions to the ecosystems will persist. The predicted levels of vegetation health effects based on the evaluation criteria are provided in Table 25, and a summary of significance is provided in Table 26.

Culturally Valued Vegetation — *There is high confidence that the Phase 2 Proposal will have a not significant impact on culturally valued vegetation.* The additional loss of vegetation within the PDA because of the Phase 2 Proposal is considered a residual effect. However, modelled predictions in the FEIS of sparse blueberry areas, and follow-up monitoring confirms that sparse distribution. Disturbed areas are not expected to become revegetated until the closure of the mine and it is assumed that some sections of the footprint will not return to baseline conditions. The predicted levels of vegetation abundance and diversity effects based on the evaluation criteria are provided in Table 25, and a summary of significance is provided in Table 26.

Table 25. Effects Assessment Summary of Phase 2 Proposal Residual Effects on Vegetation

Residual Effect	Residual Effect Evaluation Criteria					Significance of Residual Effect
	Magnitude	**Extent**	**Frequency**	**Duration**	**Reversibility**	
Change in vegetation abundance and diversity	Level I: The impact will be indistinguishable from natural variation	Level I: The impact will occur within the PDA and in confined area of the highest TSP deposition adjacent the PDA	Level I: The impact will occur once	Level II: The impact will occur through operation phase	Level II: The impact is reversible	Not significant
Change in vegetation health due to TSP and other emissions	Level I: The impact will be indistinguishable from natural variation	Level I: The impact will occur within the PDA and in confined area of the highest TSP deposition adjacent the PDA	Level III: The impact will be continuous through operations phase of the Project	Level II: The impact will occur through operation phase	Level II: The impact is reversible	Not significant
Loss of culturally valued vegetation	Level I: The impact will be indistinguishable from natural variation	Level I: The impact will occur within the PDA and in confined area of the highest TSP deposition adjacent the PDA	Level III: The impact will be continuous through operations phase of the Project	Level II: The impact will occur through operation phase	Level II: The impact is reversible	Not significant

Table 26 Significance of Potential Residual Effects on Vegetation

Effect	Significance of Predicted Residual Environmental Effect		Likelihood[a]	
	Significance Rating	Level of Confidence	Probability	Certainty
Change in vegetation abundance and diversity	N	3 (High): Vegetation cover in the RSA is well understood by regional-level mapping and vegetation monitoring for the Approved Project. To date, no discernible changes have been measured. Loss of vegetation is quantified by measures of the Project footprint.	na	na
Change in vegetation health due to TSP and other emissions	N	2 (Medium): Metal levels in plants have been collected for baseline work and follow-up impact monitoring for the approved Project. Longer-term monitoring at other arctic mines have shown some measurable impacts, but nothing significant at a regional scale.	na	na
Loss of culturally valued vegetation	N	3 (High): FEIS modelling and follow-up approved project monitoring have confirmed the low abundance of berry-producing plants (blueberries) in the RSA.	na	na

Key

Significance Rating: S = Significant, N = not Significant, P = Positive

Level of Confidence[1]: 1 = Low; 2 = Medium; 3 = High

[a]Likelihood — only applicable to significant effects

Probability: 1 = Unlikely; 2 = Moderate; 3 = Likely

Certainty[2]: 1 = Low; 2 = Medium; 3 = High

Notes

1. Level of confidence in the assignment of significance
2. Certainty around the assignment of likelihood

3.5 POTENTIAL CLIMATE CHANGE EFFECTS

Potential effects from climate change are not traditionally considered within a cumulative effects assessment but the pathways are similar. Global emissions of greenhouse gases (GHGs) are expected to cause an overall warming trend, with more rapid changes in polar latitudes such as the Arctic (Larsen et al. 2014). Over time, effects to species and ecosystems are likely to be widespread but will vary relative to realized emissions pathways (Field et al. 2014). Climate change effects interact with the project identically to cumulative effects: they result from external activities that are beyond control of the Project but have the potential to interact with direct and indirect project effects. As a result, they are considered here.

Colonization of currently unvegetated areas may increase due to greater vegetation production, caused by more rapid decomposition and higher nutrient availability (Dormann and Woodin 2002, Weintraub and Schimel 2005). Responses of plant species in the high Arctic may favour investments in reproduction rather than growth; an investment in producing greater seed crops under a higher temperature scenario may help species colonize unvegetated ground (Arft et al. 1999).

On average, vegetation biomass is expected to increase as a result of warming in the Arctic (Larsen et al. 2014). Shrubs are expected to increase at the expense of other plant functional types. Shrub biomass, cover and distribution have expanded in many areas of the Arctic over recent decades, likely as a result of climate change (Sturm et al. 2001, 2005, Tape et al. 2006, Myers-Smith et al. 2011, Ropars and Boudreau 2012). On Ellesmere Island, bryophyte and evergreen shrub abundances increased while deciduous shrub, forb, graminoid and lichen cover did not change (Hudson and Henry 2009). Experimental manipulation of warmth shading and fertilization revealed that responses are community-dependent: shrubs and bryophytes increased in two of three communities as a response to increased warming but lichen abundance decreased in all communities (Edwards and Henry 2016).

Warmer climate in the Canadian Arctic increased plant biomass in summer pastures but there was a decline in caribou populations, suggesting the quality of forage had diminished. This may signal a transition from a system with low plant biomass modulated by cyclic caribou populations to one dominated by low quality or non-edible shrubs and diminishing caribou populations (Fauchald et al. 2017). Not all studies support an expansion of shrub coverage in the Arctic: a meta-analysis of responses of tundra plants to experimental warming found a stronger positive response of herbaceous plants than woody plants to warming (Arft et al. 1999).

There is high confidence that the Project will have a residual effect on vegetation abundance and distribution (Section 3.4.4). Climate change is not expected to interact with this effect since it will be a direct effect of vegetation clearing within the PDA. Following completion of the Project, climate change may increase the rate of re-vegetation but is unlikely to have a significant effect.

There is moderate confidence that the Project will negatively affect vegetation health adjacent to the PDA because of dust and/or metals deposition. Climate change may interact with this effect: dust and/or metals deposition and climate change may have an additive effect on the distribution and abundance of some plant species or types and may enhance the transition to greater shrub and graminoid abundance and distribution.

If this occurs, it will be limited to areas adjacent to the PDA that are exposed to greater dust and/or metals deposition.

Uncertainty associated with these conclusions include the realized emissions pathways over the lifetime of the Project, the accuracy of climate models to predict responses within the Arctic, the response of vegetation to dust and/or metals deposition and the direction and magnitude of interaction of this response and climate change.

3.6 MITIGATION AND MONITORING PLAN UPDATES

Based on the effects assessment for the Phase 2 Proposal the current Baffinland Terrestrial Environment Mitigation and Monitoring Plan (TEMMP, BAF-PH1-830-P16-0027; (Baffinland Iron Mines Corporation 2016*a*) does not require any updates to mitigate the Phase 2 Proposal related effects on vegetation. The mitigation measures in place for the Approved Project apply to the Phase 2 Proposal activities.

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ATTACHMENT 1 VEGETATION ABUNDANCE MONITORING SITES (2014 AND 2016)

Table A-1. Vegetation abundance monitoring sites, 2014 and 2016.

Site Location	Transect/ Control No.	Plot ID[1]	Actual distance to PDA (m)	Treatment type	Latitude	Longitude
Mine Site	1	T1D30A	29	Open	71.32020	-79.35944
Mine Site	1	T1D30X	29	Closed	71.32016	-79.35923
Mine Site	1	T1D100A	102	Open	71.31966	-79.36069
Mine Site	1	T1D100X	102	Closed	71.31964	-79.36049
Mine Site	1	T1D750A	751	Open	71.31495	-79.37126
Mine Site	1	T1D750X	751	Closed	71.31495	-79.37126
Mine Site	1	T1D1200A	1,191	Open	71.31239	-79.38171
Mine Site	1	T1D1200X	1,186	Closed	71.31243	-79.38161
Mine Site	2	T2D30A	19	Open	71.31922	-79.19151
Mine Site	2	T2D30X	16	Closed	71.31921	-79.19163
Mine Site	2	T2D100A	175	Open	71.31862	-79.18756
Mine Site	2	T2D100X	174	Closed	71.31871	-79.18748
Mine Site	2	T2D750A	765	Open	71.31549	-79.17373
Mine Site	2	T2D750X	765	Closed	71.31549	-79.17373
Mine Site	2	T2D1200A	1,178	Open	71.31269	-79.16479
Mine Site	2	T2D1200B	1,177	Open	71.31271	-79.16478
Mine Site	2	T2D1200X	1,179	Closed	71.31264	-79.16482
Mine Site	3	T3D30A	30	Open	71.34010	-79.31164
Mine Site	3	T3D30X	34	Closed	71.34013	-79.31172
Mine Site	3	T3D100A	87	Open	71.34042	-79.31307
Mine Site	3	T3D100B	98	Open	71.34051	-79.31317
Mine Site	3	T3D100X	103	Closed	71.34054	-79.31329
Mine Site	3	T3D750A	734	Open	71.34668	-79.31554

Site Location	Transect/ Control No.	Plot ID[1]	Actual distance to PDA (m)	Treatment type	Latitude	Longitude
Mine Site	3	T3D750X	730	Closed	71.34664	-79.31550
Mine Site	3	T3D71200A	1,445	Open	71.35172	-79.32806
Mine Site	3	T3D1200X	1,445	Closed	71.35172	-79.32806
Tote Road	4	T4D30A	35	Open	71.34193	-79.54399
Tote Road	4	T4D30X	36	Closed	71.34193	-79.54398
Tote Road	4	T4D100A	95	Open	71.31234	-79.54282
Tote Road	4	T4D100X	98	Closed	71.34231	-79.54267
Tote Road	4	T4D750A	830	Open	71.34631	-79.52631
Tote Road	4	T4D750B	831	Open	71.34626	-79.52620
Tote Road	4	T4D750X	832	Closed	71.34362	-79.52609
Tote Road	4	T4D1200A	1,268	Open	71.34653	-79.51250
Tote Road	4	T4D1200X	1,268	Closed	71.34653	-79.51250
Tote Road	5	T5D30A	21	Open	71.37588	-79.73111
Tote Road	5	T5D30X	22	Closed	71.37586	-79.73100
Tote Road	5	T5D100A	86	Open	71.37511	-79.73049
Tote Road	5	T5D100X	89	Closed	71.37508	-79.73042
Tote Road	5	T5D750A	730	Open	71.36990	-79.73830
Tote Road	5	T5D750B	738	Open	71.36984	-79.73837
Tote Road	5	T5D750X	740	Closed	71.36983	-79.73842
Tote Road	5	T5D1200A	1,106	Open	71.36624	-79.73808
Tote Road	5	T5D1200X	1,139	Closed	71.36585	-79.73741
Tote Road	6	T6D30A	42	Open	71.38194	-79.99419
Tote Road	6	T6D30B	44	Open	71.38197	-79.99432
Tote Road	6	T6D30X	41	Closed	71.38196	-79.99448
Tote Road	6	T6D100A	91	Open	71.38248	-79.99201

Site Location	Transect/ Control No.	Plot ID[1]	Actual distance to PDA (m)	Treatment type	Latitude	Longitude
Tote Road	6	T6D100X	91	Closed	71.38248	-79.99219
Tote Road	6	T6D750A	694	Open	71.38803	-79.99321
Tote Road	6	T6D750X	694	Closed	71.38803	-79.99321
Tote Road	6	T6D1200A	1,225	Open	71.39247	-79.98299
Tote Road	6	T6D1200X	1,226	Closed	71.39249	-79.98305
Milne Port	7	T7D30A	26	Open	71.87114	-80.87792
Milne Port	7	T7D30X	26	Closed	71.87122	-80.87794
Milne Port	7	T7D100A	105	Open	71.87211	-80.87576
Milne Port	7	T7D100X	99	Closed	71.87212	-80.87593
Milne Port	7	T7D750A	884	Open	71.86808	-80.85032
Milne Port	7	T7D750B	874	Open	71.86797	-80.85041
Milne Port	7	T7D750X	871	Open	71.86788	-80.85025
Milne Port	7	T7D1200A	1,136	Open	71.87198	-80.84419
Milne Port	7	T7D1200B	1,135	Open	71.87201	-80.84426
Milne Port	7	T7D1200X	1,133	Closed	71.87203	-80.84431
Milne Port	8	T8D30A	51	Open	71.88273	-80.87804
Milne Port	8	T8D30X	54	Closed	71.88277	-80.87793
Milne Port	8	T8D100A	90	Open	71.88243	-80.87705
Milne Port	8	T8D100X	94	Closed	71.88245	-80.87691
Milne Port	8	T8D750A	818	Open	71.88108	-80.85626
Milne Port	8	T8D750B	822	Open	71.88110	-80.85614
Milne Port	8	T8D750X	826	Closed	71.88111	-80.85604
Milne Port	8	T8D1200A	1,098	Open	71.88471	-80.84666
Milne Port	8	T8D1200X	1,104	Closed	71.88476	-80.84648
Mine Site	9	T9D30A	32	Open	71.29982	-79.26338

Site Location	Transect/ Control No.	Plot ID[1]	Actual distance to PDA (m)	Treatment type	Latitude	Longitude
Mine Site	9	T9D30X	32	Closed	71.29981	-79.26321
Mine Site	9	T9D100A	135	Open	71.29912	-79.26827
Mine Site	9	T9D100X	134	Closed	71.29915	-79.26846
Mine Site	9	T9D750A	713	Open	71.29443	-79.27907
Mine Site	9	T9D750B	708	Open	71.29448	-79.27903
Mine Site	9	T9D750X	701	Closed	71.29453	-79.27890
Mine Site	9	T9D1200A	1,186	Open	71.29173	-79.29365
Mine Site	9	T9D1200X	1,182	Closed	71.29176	-79.29358
Mine Site	10	T10D30A	28	Open	71.34274	-79.29750
Mine Site	10	T10D30X	34	Closed	71.34280	-79.29755
Mine Site	10	T10D100A	127	Open	71.34355	-79.29861
Mine Site	10	T10D100B	127	Open	71.34355	-79.29861
Mine Site	10	T10D100X	127	Closed	71.34355	-79.29861
Mine Site	10	T10D750A	650	Open	71.34911	-79.29802
Mine Site	10	T10D750X	650	Closed	71.34911	-79.29802
Mine Site	10	T10D1200A	1,219	Open	71.35276	-79.31007
Mine Site	10	T10D1200X	1,219	Closed	71.35276	-79.31007
Mine Site	11	T11D30A	29	Open	71.31259	-79.19954
Mine Site	11	T11D30X	17	Closed	71.31273	-79.19974
Mine Site	11	T11D100A	233	Open	71.31095	-79.19546
Mine Site	11	T11D100X	233	Closed	71.31095	-79.19546
Mine Site	11	T11D750A	804	Open	71.30648	-79.18466
Mine Site	11	T11D750B	805	Open	71.30640	-79.18483
Mine Site	11	T11D750X	802	Closed	71.30642	-79.18486
Mine Site	11	T11D1200A	1,219	Open	71.30536	-79.17309

Site Location	Transect/ Control No.	Plot ID[1]	Actual distance to PDA (m)	Treatment type	Latitude	Longitude
Mine Site	11	T11D1200X	1,225	Closed	71.30538	-79.17287
Tote Road	12	T12D30A	55	Open	71.41457	-80.1019
Tote Road	12	T12D30X	50	Closed	71.41467	-80.1021
Tote Road	12	T12D100A	113	Open	71.41430	-80.10019
Tote Road	12	T12D100X	113	Closed	71.4143	-80.10019
Tote Road	12	T12D750A	757	Open	71.41617	-80.08279
Tote Road	12	T12D750B	757	Open	71.41617	-80.08279
Tote Road	12	T12D750X	757	Closed	71.41617	-80.08279
Tote Road	12	T12D1200A	1,141	Open	71.41851	-80.07372
Tote Road	12	T12D1200X	1,140	Closed	71.41859	-80.07383
Tote Road	13	T13D30A	35	Open	71.42143	-80.10964
Tote Road	13	T13D30B	35	Open	71.42143	-80.10964
Tote Road	13	T13D30X	35	Closed	71.42143	-80.10964
Tote Road	13	T13D100A	87	Open	71.42149	-80.10794
Tote Road	13	T13D100X	87	Closed	71.42149	-80.10794
Tote Road	13	T13D750A	669	Open	71.42509	-80.09329
Tote Road	13	T13D750X	674	Closed	71.42512	-80.09317
Tote Road	13	T13D1200A	1,166	Open	71.42884	-80.08349
Tote Road	13	T13D1200X	1,165	Closed	71.42895	-80.08375
Milne Port	14	T14D30A	43	Open	71.87797	-80.87826
Milne Port	14	T14D30X	37	Closed	71.87815	-80.87845
Milne Port	14	T14D100A	129	Open	71.87736	-80.87571
Milne Port	14	T14D100X	118	Closed	71.87738	-80.87601
Milne Port	14	T14D750A	756	Open	71.87649	-80.85755
Milne Port	14	T14D750X	749	Closed	71.87649	-80.85775

Site Location	Transect/ Control No.	Plot ID[1]	Actual distance to PDA (m)	Treatment type	Latitude	Longitude
Milne Port	14	T14D1200A	1,178	Open	71.87772	-80.84550
Milne Port	14	T14D1200B	1,173	Open	71.87770	-80.84564
Milne Port	14	T14D1200X	1,170	Closed	71.87766	-80.84573
Milne Port	15	T15D30A	48	Open	71.87430	-80.87769
Milne Port	15	T15D30X	50	Closed	71.87434	-80.87763
Milne Port	15	T15D100A	104	Open	71.87393	-80.87603
Milne Port	15	T15D100X	100	Closed	71.87391	-80.87615
Milne Port	15	T15D750A	812	Open	71.87411	-80.85563
Milne Port	15	T15D750X	806	Closed	71.87427	-80.85583
Milne Port	15	T15D1200A	1,130	Open	71.87504	-80.84659
Milne Port	15	T15D1200X	1,126	Closed	71.87500	-80.84671
Total	**--**	**133 plots**	--	--	--	--
Control	1	REF1A	19,450	Open	71.16658	-79.71055
Control	1	REF1B	19,448	Open	71.16658	-79.71037
Control	1	REF1X	19,450	Closed	71.16655	-79.71028
Control	2	REF2A	20,409	Open	71.51695	-78.91855
Control	2	REF2B	20,410	Open	71.51694	-78.91845
Control	2	REF2X	20,407	Closed	71.51690	-78.91839
Control	3	REF3A	20,595	Open	71.85313	-79.99586
Control	3	REF3B	20,593	Open	71.85307	-79.99581
Control	3	REF3X	20,594	Closed	71.85302	-79.99567
Control	4	REF4A	21,178	Open	71.88674	-80.05467
Control	4	REF4B	21,185	Open	71.88678	-80.05450
Control	4	REF4X	21,190	Closed	71.88680	-80.05435
Control	5	REF5A	33,185	Open	71.65634	-79.34103

Site Location	Transect/ Control No.	Plot ID[1]	Actual distance to PDA (m)	Treatment type	Latitude	Longitude
Control	5	REF5B	33,184	Open	71.65635	-79.34108
Control	5	REF5X	33,184	Closed	71.65638	-79.34125
Control	6	REF6A	16,435	Open	71.29160	-80.39122
Control	6	REF6B	16,429	Open	71.29161	-80.39097
Control	6	REF6X	16,432	Closed	71.29155	-80.39089
Total	**--**	**18 plots**	--	--	--	--
Total (66 sites)	**--**	**151 plots**	--	--	--	--

ATTACHMENT 2 UPDATED BASELINE VEGETATION SPECIES LIST (2005-2016)

Table B-1. Updated baseline vegetation species list, 2005–2016.

Scientific name[1]	Common name[1]	Plant Group	Abundance Rank[2]	General Status[3] Nunavut Rank	National Rank
Alopecurus magellanicus	alpine foxtail	Graminoid	Common	4	4
Androsace septentrionalis	fairy candelabra	Forb	Trace	4	4
Antennaria friesiana	Fries' pussy-toes	Forb	Trace	4	4
Arabidopis arenicola	arctic rockcress	Forb	Uncommon	4	4
Arctagrostis latifolia ssp. *latifolia*	polar grass	Graminoid	Uncommon	4	4
Arctous alpina	black bearberry	Shrub	Trace	4	4
Arenaria humifusa	salt marsh sandwort	Forb	Uncommon	4	4
Armeria scabra	arctic thrift	Forb	Uncommon	4	4
Astragalus alpinus	alpine milk-vetch	Forb	Uncommon	4	4
Bistorta vivipara	alpine bistort, Inuit peanuts	Forb	Common	4	4
Braya glabella ssp. *purpurascens*	purple braya	Forb	Common	4	4
Calamagrostis purpurascens	purple reed bentgrass	Graminoid	-	4	4
Campanula uniflora	arctic harebell	Forb	Trace	4	4
Cardamine bellidifolia	alpine bittercress	Forb	Uncommon	4	4
Cardamine pratensis ssp. *angustifolia*	cuckoo-flower	Forb	Trace	4	4
Carex aquatilis ssp. *stans*	aquatic sedge	Graminoid	Uncommon	4	4
Carex atrofusca	dark brown sedge	Graminoid	Uncommon	4	4
Carex bigelowii ssp. *bigelowii*	Bigelow's sedge	Graminoid	Uncommon	-	-
Carex capillaris ssp. *fuscidula*	hair sedge	Graminoid	Trace	-	-
Carex chordorrhiza	creeping sedge	Graminoid	Trace	4	4
Carex fuliginosa ssp. *misandra*	short leaf sedge	Graminoid	Common	4	4
Carex glacialis	glacier sedge	Graminoid	Rare	4	4
Carex glareosa	gravel sedge	Graminoid	-	4	4
Carex holostoma	arctic marsh sedge	Graminoid	-	4	4
Carex marina	seashore sedge	Graminoid	Rare	4	4
Carex maritima	maritime sedge	Graminoid	Uncommon	4	4
Carex membranacea	fragile sedge	Graminoid	Common	4	4
Carex nardina	nard sedge	Graminoid	Uncommon	4	4
Carex norvegica	Norway sedge	Graminoid	-	4	4

Scientific name[1]	Common name[1]	Plant Group	Abundance Rank[2]	General Status[3]	
				Nunavut Rank	National Rank
Carex rariflora	loose flowered alpine sedge	Graminoid	-	4	4
Carex rupestris	curly sedge, rock sedge	Graminoid	Common	4	4
Carex saxatilis	russet sedge	Graminoid	Common	4	4
Carex scirpoidea	northern singlespike sedge	Graminoid	Common	4	4
Carex supina ssp. *spaniocarpa*	weak arctic sedge	Graminoid	-	4	4
Carex ursina	bear sedge	Graminoid	-	4	4
Cassiope tetragona	mountain heather	Shrub	Common	4	4
Cerastium alpinum	mouse-eared chickweed	Forb	Common	4	4
Cerastium arcticum var. *arcticum*	arctic mouse-ear chickweed	Forb	Trace	4	4
Cerastium beeringianum	Bering chickweed	Forb	Uncommon	4	4
Cetraria delisei	snow-bed Iceland lichen	Lichen	Common	4	4
Cetraria islandica ssp. *crispiformis*	Iceland lichen	Lichen	Common	-	-
Cetraria spp.	*Cetraria* species	Lichen	Uncommon	-	-
Chamerion angustifolium	tall fireweed	Forb	-	4	4
Chamerion latifolium	river beauty, broad-leaved willowherb	Forb	Common	4	4
Chrysosplenium tetrandrum	golden saxifrage	Forb	Trace	4	4
Cladina arbuscula	reindeer lichen	Lichen	Trace	4	3
Cladina mitis	green reindeer lichen	Lichen	Trace	4	4
Cladina rangiferina	gray reindeer lichen	Lichen	Trace	4	4
Cladina stellaris	star-tipped lichen	Lichen	Rare	4	4
Cladonia spp.	*Cladonia* species	Lichen	Uncommon	-	-
Cochlearia groenlandica	scurvy-grass	Forb	Uncommon	4	4
Cystopteris fragilis	fragile fern	Fern	-	4	4
Deschampsia brevifolia	tufted hairgrass	Graminoid	Trace	4	4
Diapensia lapponica	pincushion plant	Shrub	-	4	4
Draba alpina	alpine whitlowgrass	Forb	Uncommon	4	4

Scientific name[1]	Common name[1]	Plant Group	Abundance Rank[2]	General Status[3] Nunavut Rank	National Rank
Draba arctica	arctic draba	Forb	-	-	-
Draba cinerea	greyleaf whitlowgrass	Forb	Uncommon	4	4
Draba corymbosa	flattop whitlowgrass	Forb	Common	4	4
Draba fladnizensis	arctic draba, Austrian draba	Forb	-	4	4
Draba glabella	smooth whitlowgrass	Forb	Trace	4	4
Draba lactea	milky draba	Forb	Common	4	4
Draba nivalis	snow draba	Forb	Uncommon	4	4
Draba pilosa	pilose draba	Forb	Common	4	4
Draba simmonsii	Simmons' draba	Forb	Common	4	4
Draba subcapitata	Ellesmere Island draba	Forb	Rare	4	4
Dryas integrifolia	mountain avens	Shrub	Common	4	4
Dryopteris fragrans	fragrant shield fern	Fern	-	4	4
Dupontia fisheri	Fisher's tundragrass	Graminoid	Common	4	4
Elymus violaceus	violet wheatgrass	Graminoid	-	4	5
Empetrum nigrum	crowberry; black berry	Shrub	Rare	4	4
Epilobium arcticum	arctic willowherb	Forb	Trace	4	4
Equisetum arvense	common horsetail	Forb	Uncommon	4	4
Equisetum variegatum	variegated scouring rush	Forb	Common	4	4
Erigeron humilis	arctic alpine fleabane	Forb	Trace	4	4
Erigeron uniflorus ssp. *eriocephalus*	fleabane	Forb	Trace	4	4
Eriophorum angustifolium ssp. *triste*	tall cottongrass	Graminoid	Common	-	-
Eriophorum callitrix	arctic cottongrass	Graminoid	-	4	4
Eriophorum russeolum	red cottongrass	Graminoid	Uncommon	4	4
Eriophorum scheuchzeri	Scheuchzer's cotton-grass	Graminoid	Common	4	4
Eriophorum vaginatum	tussock cottongrass	Graminoid	Trace	-	-
Eutrema edwardsii	Edward's mock wallflower	Forb	Trace	4	4

Scientific name[1]	Common name[1]	Plant Group	Abundance Rank[2]	General Status[3]	
				Nunavut Rank	National Rank
Festuca baffinensis	Baffin fescue	Graminoid	Uncommon	4	4
Festuca brachyphylla	alpine fescue	Graminoid	Uncommon	4	4
Festuca hyperborea	boreal fescue	Graminoid	-	4	4
Festuca rubra ssp. *rubra*	red fescue	Graminoid	-	4	4
Flavocetraria cucullata	whirling dervish	Lichen	Uncommon	4	4
Flavocetraria nivalis	ballroom dervish	Lichen	Uncommon	4	4
Hierochloë alpina	alpine sweet grass	Graminoid	Common	4	4
Hierochloe pauciflora	arctic holy grass	Graminoid	Trace	4	4
Hippuris vulgaris	mare's tail	Aquatic	-	4	4
Honckenya peploides	seabeach sandwort	Forb	Rare	4	4
Hulteniella integrifolia	small arctic daisy	Forb	Common	4	4
Huperzia selago	mountain club-moss	Other	Uncommon	4	4
Juncus arcticus	arctic rush	Graminoid	-	4	4
Juncus biglumis	twoflowered rush	Graminoid	Common	4	4
Juncus castaneus	chestnut sedge	Graminoid	Trace	4	4
Juncus triglumis	northern white rush	Graminoid	-	4	4
Kobresia myosuroides	Bellardi bog sedge	Graminoid	Common	4	4
Kobresia simpliciuscula ssp. *subholarctica*	simple bog sedge	Graminoid	Common	-	-
Koenigia islandica	koenigia, island purslane	Forb	-	4	4
Ledum palustre	Labrador tea	Shrub	-	4	4
Leymus mollis	American dunegrass	Graminoid	Rare	4	4
Luzula confusa	northern wood rush	Graminoid	Uncommon	4	4
Luzula nivalis	arctic woodrush	Graminoid	Trace	4	4
Mertensia maritima	seaside bluebells	Forb	Trace	4	4
Micranthese hieracifolia	hawkweed-leaved saxifrage	Forb	Uncommon	4	4
Micranthes nivalis	snow saxifrage	Forb	Common	4	4
Minuartia biflora	mountain stitchwort	Forb	-	4	4
Minuartia elegans	northern sandwort	Forb	Uncommon	4	-
Minuartia rossii	Ross' sandwort	Forb	Uncommon	4	4
Minuartia rubella	reddish sandwort	Forb	Uncommon	4	4

Scientific name[1]	Common name[1]	Plant Group	Abundance Rank[2]	General Status[3]	
				Nunavut Rank	National Rank
Minuartia stricta	bog stitchwort	Forb	-	4	4
Moss spp.	moss species	Moss	Common	-	-
Mushroom spp.	mushroom species	Mushroom	Trace	-	-
Oxyria digyna	mountain sorrel, sweetleaf	Forb	Common	4	4
Oxytropis maydelliana	Maydell's oxytrope, Inuit carrot	Forb	Common	4	4
Oxytropis nigrescens var. *uniflora*	one-flower blackish locoweed	Forb	Trace	4	4
Papaver dahlianum	polar poppy	Forb	Trace	4	5
Papaver lapponicum	Lapland poppy	Forb	Trace	4	4
Papaver radicatum ssp. *radicatum*	arctic poppy	Forb	Common	-	-
Pedicularis capitata	capitate lousewort	Forb	Common	4	4
Pedicularis hirsuta	hairy lousewort	Forb	Common	4	4
Pedicularis lanata	Woolly lousewort	Forb	Uncommon	4	4
Pedicularis langsdorffii	arctic lousewort	Forb	-	4	4
Pedicularis sudetica ssp. *albolabiata*	Sudetan lousewort	Forb	Trace	4	4
Phippsia algida	icegrass	Graminoid	Trace	4	4
Physaria arctica	arctic bladderpod	Forb	Common	4	4
Pleuropogon sabinei	semaphore grass	Graminoid	Trace	4	4
Poa abbreviata	northern bluegrass	Graminoid	Trace	4	4
Poa alpina	alpine bluegrass	Graminoid	-	4	4
Poa arctica ssp. *arctica*	arctic bluegrass	Graminoid	Common	-	-
Poa arctica ssp. *caespitans*	high arctic bluegrass	Graminoid	-	-	-
Poa glauca	glaucous bluegrass	Graminoid	Common	4	4
Poa pratensis ssp. *alpigena*	Kentucky bluegrass	Graminoid	-	-	-
Poa pratensis ssp. *colpodea*	Kentucky bluegrass	Graminoid	-	-	-
Potentilla hyparctica	arctic cinquefoil	Forb	Trace	4	4
Potentilla pulchella	finely-divided leaves	Forb	Common	4	4
Potentilla rubricaulis	Rocky mountain cinquefoil	Forb	Trace	4	4
Potentilla subahaliana	Vahl's cinquefoil	Forb	Common	4	4

Scientific name[1]	Common name[1]	Plant Group	Abundance Rank[2]	General Status[3]	
				Nunavut Rank	National Rank
Potentilla villosula	finely villous cinquefoil	Forb	Common	4	-
Puccinellia phryganodes	creeping alkaligrass	Graminoid	-	4	4
Puccinellia tenella ssp. *langeana*	alkaligrass	Graminoid	Trace	-	-
Puccinellia vahliana	Vahl's alkaligrass	Graminoid	-	4	4
Pyrola grandiflora	large-flowered wintergreen	Forb	Uncommon	4	4
Ranunculus aquatilis	white water-buttercup	Forb	-	4	4
Ranunculus hyperboreus	arctic crowfoot, arctic buttercup	Forb	Trace	4	4
Ranunculus nivalis	snow buttercup	Forb	Trace	4	4
Ranunculus pedatifidus	surefoot buttercup	Forb	-	4	4
Ranunculus pygmaeus	pygmy buttercup	Forb	Trace	4	4
Ranunculus sulphureus	sulfur buttercup	Forb	-	4	4
Rhododendron lapponicum	Lapland rosebay	Shrub	Trace	4	4
Sagina caespitosa	tufted pearlwort	Forb	-	4	4
Sagina nivalis	snow pearlwort	Forb	Common	4	4
Salix arctica	arctic willow	Shrub	Common	4	4
Salix calcicola	woolly willow	Shrub	-	4	4
Salix herbacea	snowbed willow	Shrub	Common	4	4
Salix reticulata	net-vein willow	Shrub	Common	4	4
Salix richardsonii	Richardson's willow	Shrub	Common	4	4
Saxifraga aizoides	yellow mountain saxifrage	Forb	Uncommon	4	4
Saxifraga cernua	nodding saxifrage	Forb	Common	4	4
Saxifraga cespitosa	tufted alpine saxifrage	Forb	Common	4	4
Saxifraga foliolosa	leafystem saxifrage	Forb	Common	4	4
Saxifraga hirculus	yellow marsh saxifrage	Forb	Common	4	4
Saxifraga hyperborea	arctic saxifrage	Forb	Uncommon	4	4
Saxifraga oppositifolia	purple saxifrage	Forb	Common	4	4
Saxifraga paniculata	white mountain saxifrage	Forb	-	4	3
Saxifraga rivularis	brooklet saxifrage	Forb	Trace	4	4

Scientific name[1]	Common name[1]	Plant Group	Abundance Rank[2]	General Status[3]	
				Nunavut Rank	National Rank
Saxifraga tricuspidata	prickly saxifrage	Forb	Common	4	4
Silene acaulis	moss campion	Forb	Common	4	4
Silene involucrata	arctic campion, white bladder campion	Forb	Uncommon	4	4
Silene sorensensis	three-flowered campion	Forb	-	4	4
Silene uralensis ssp. *uralensis*	red bladder campion	Forb	Common	4	4
Stellaria humifusa	seashore chickweed	Forb	-	4	4
Stellaria longipes	long-stalked starwort	Forb	Common	4	4
**Taraxacum ceratophorum*	horned dandelion	Forb	Rare	4	2
Taraxacum hyparcticum	high arctic dandelion	Forb	Trace	4	4
Taraxacum phymatocarpum	northern dandelion	Forb	Trace	4	4
Tephroseris palustris	mastodon flower, marsh ragwort	Forb	Uncommon	4	4
Thamnolia vermicularis	universal whiteworm	Lichen	Common	4	4
Tofieldia coccinea	northern false tofieldia	Forb	Trace	4	4
Tofieldia pusilla	small tofieldia	Forb	Trace	4	4
Tripleurospermum maritimum ssp. *phaeocephala*	seashore chamomile	Forb	Rare	-	-
Trisetum spicatum	spike trisetum	Graminoid	Trace	4	4
Vaccinium uliginosum	blueberry	Shrub	Uncommon	4	4
Woodsia glabella	woodsia	Fern	Uncommon	4	4
Total	**184**	--	--	--	--

Scientific name[1]	Common name[1]	Plant Group	Abundance Rank[2]	General Status[3]	
				Nunavut Rank	National Rank

[1] Primary reference flora used was the online version of the Flora of the Canadian Arctic Archipelago (Aiken et al. 2007). The Secondary reference used was the online version of the Flora of North America (FNA 2014, 2016). Lichen species were referenced using Lichens of North America (Brodo et al. 2001).

[2] Species abundance ranks are based on the relative probability of occurrence across the landscape:

Common: > 25% observed occurrence, found in suitable habitat; a common species that is widespread and abundant; occurrence is highest in relation to other species on the landscape.

Uncommon: 5-24% observed occurrence, found in most suitable habitat; a species that is found in low numbers, sporadically or is localized; where it is found it may be prevalent, however, its occurrence is not more than 24% in relation to other species on the landscape.

Trace: < 5% observed occurrence, seen in more than one site but in low numbers; a species that is sometimes encountered, but its occurrence on the landscape is very uncommon; where it is found there are few individuals and its occurrence is 5% or less.

Rare: only seen at one site or in low numbers; a species that occupies uncommon habitats and is either few in number or sporadically abundant; its presence and abundance on the landscape is not often encountered.

"-" indicates a species that was observed prior to 2014 and 2016 monitoring; therefore, an abundance rank cannot be defined.

[3] General Status Ranks for Nunavut and Canada are provided by Wild Species (Canadian Endangered Species Conservation Council 2011). **Ranks**: 0.2=Extinct; 0.1=Extirpated; 1=At Risk; 2=May Be At Risk; 3=Sensitive; 4=Secure; 5=Undetermined; 6=Not Assessed; 7=Exotic; 8= Accidental; "-" indicates a subspecies which are not currently ranked.

* = "May Be At Risk" species for Nunavut (CESCC 2011).

ATTACHMENT 3 VEGETATION AND SOIL TRACE METALS SAMPLE SITES (2012-2016)

Table C-1. Vegetation and soil trace metals sample sites, including control sites (*), 2012–2016.

Location	Site ID[1]	Soil	Lichen	Willow	Blueberry	Distance to PDA (m)[2]	Distance Category	Distance Class (m)	Associated Dust fall Site[3]	Latitude	Longitude
2016 Sampling											
Milne Port	L-91	1	1			67	Near	0–100	n/a	71.8819	-80.8780
Milne Port	L-92	1	1			46	Near	0–100	n/a	71.8814	-80.8786
Milne Port	L-93	1	1			173	Far	101–1000	n/a	71.8818	-80.8750
Milne Port	L-94	1	1			24	Near	0–100	n/a	71.8809	-80.8791
Milne Port	L-95	1	1			30	Near	0–100	n/a	71.8801	-80.8789
Milne Port	L-96	1	1			45	Near	0–100	n/a	71.8791	-80.8783
Milne Port	L-97	1	1			57	Near	0–100	n/a	71.8785	-80.8779
Milne Port	L-98	1	1			40	Near	0–100	n/a	71.8777	-80.8783
Milne Port	L-99	1	1			17	Near	0–100	n/a	71.8772	-80.8789
Milne Port	L-100	1	1			37	Near	0–100	n/a	71.8767	-80.8783
Milne Port	L-101	1	1			51	Near	0–100	n/a	71.8761	-80.8778
Milne Port	L-102	1	1			424	Far	101–1000	n/a	71.8757	-80.8670
Milne Port	L-103	1	1			650	Far	101–1000	n/a	71.8765	-80.8606
Milne Port	L-104	1	1			805	Far	101–1000	n/a	71.8748	-80.8559
Milne Port	L-105	1	1			1823*	Control	>1000	n/a	71.8770	-80.8268
Milne Port	L-106	1	1			3218*	Control	>1000	DF-P-03	71.8999	-80.7902
Tote Road	L-68	1	1			55	Near	0–100	n/a	71.3884	-79.8766
Tote Road	L-69	1	1			24	Near	0–100	n/a	71.3904	-79.8657
Tote Road	L-70	1	1			91	Near	0–100	n/a	71.3933	-79.8671
Tote Road	L-71	1	1			52	Near	0–100	n/a	71.3944	-79.8560
Tote Road	L-72	1	1			56	Near	0–100	n/a	71.3967	-79.8428

Location	Site ID[1]	Soil	Lichen	Willow	Blueberry	Distance to PDA (m)[2]	Distance Category	Distance Class (m)	Associated Dust fall Site[3]	Latitude	Longitude
Tote Road	L-73	1	1			63	Near	0–100	n/a	71.3984	-79.8325
Tote Road	L-74	1	1			71	Near	0–100	DF-RS-03	71.3962	-79.8227
Tote Road	L-75	1	1			231	Far	101–1000	n/a	71.3948	-79.8217
Tote Road	L-76	1	1			546	Far	101–1000	DF-RS-02	71.3896	-79.8326
Tote Road	L-77	1	1			953	Far	101–1000	DF-RS-07	71.4079	-79.8187
Tote Road	L-78	1	1			36	Near	0-100	n/a	71.3922	-79.7995
Tote Road	L-79	1	1			72	Near	0-100	n/a	71.3891	-79.7862
Tote Road	L-80	1	1			77	Near	0-100	n/a	71.3904	-79.7759
Tote Road	L-107	1	1			6121*	Control	>1000	n/a	71.3259	-79.8008
Tote Road	L-108	1	1			6855*	Control	>1000	n/a	71.4515	-79.7117
Tote Road	L-116	1	1			411	Far	101–1000	n/a	71.3833	-79.8862
Mine Site	L-81	1	1			58	Near	0–100	n/a	71.3001	-79.2737
Mine Site	L-82	1	1			72	Near	0–100	n/a	71.2997	-79.2679
Mine Site	L-83	1	1			90	Near	0–100	n/a	71.3101	-79.2012
Mine Site	L-84	1	1			86	Near	0–100	n/a	71.3101	-79.2043
Mine Site	L-85	1	1			68	Near	0–100	n/a	71.3102	-79.2114
Mine Site	L-86	1	1			50	Near	0–100	n/a	71.3094	-79.2215
Mine Site	L-87	1	1			64	Near	0–100	n/a	71.3089	-79.2263
Mine Site	L-88	1	1			59	Near	0–100	n/a	71.3075	-79.2346
Mine Site	L-89	1	1			92	Near	0–100	n/a	71.3047	-79.2379
Mine Site	L-90	1	1			401	Far	101–1000	n/a	71.3182	-79.3691
Mine Site	L-109	1	1			8808*	Control	>1000	DF-M-04	71.2208	-79.3274
Mine Site	L-110	1	1			2449*	Control	>1000	n/a	71.2981	-79.1020

Location	Site ID[1]	Soil	Lichen	Willow	Blueberry	Distance to PDA (m)[2]	Distance Category	Distance Class (m)	Associated Dust fall Site[3]	Latitude	Longitude
Mine Site	L-111	1	1			10386*	Control	>1000	n/a	71.3860	-78.9034
Mine Site	L-112	1	1			1046*	Control	>1000	DF-M-06	71.3202	-79.1594
Mine Site	L-113	1	1			1185*	Control	>1000	DF-M-06	71.3196	-79.1560
Mine Site	L-114	1	1			390	Far	101–1000	n/a	71.3098	-79.1921
Mine Site	L-115	1	1			451	Far	101−1000	n/a	71.3105	-79.1894
Mine Site	L-117	1	1			50	Near	0−100	n/a	71.2998	-79.2657
2016 Total	**50**	**50**	**50**								
2014 Sampling											
Milne Port	L-56	1	1	1		0	Near	0−100	DF04-P	71.87094399	-80.8824
Milne Port	L-57	1		1		0	Near	0–100	DF06-P	71.88576596	-80.8790
Milne Port	L-58	1	1			0	Near	0–100	DF07-P	71.8837833	-80.9159
Tote Road	L-59	1	1	1		13,177*	Control	>1000	n/a	71.77518301	-80.1047
Tote Road	L-60	1	1	1	1	0	Near	0–100	n/a	71.34229903	-79.5512
Tote Road	L-61	1	1	1	1	417	Far	101-1000	n/a	71.33833104	-79.5246
Tote Road	L-63	1	1	1		10,630*	Control	>1000	n/a	71.88054102	-80.4592
Mine Site	L-64	1	1			1,184*	Control	>1000	DF06-M	71.31956303	-79.1559
Mine Site	L-67	1	1	1	1	3,347*	Control	>1000	DF09-M	71.29357201	-79.4128
Rail	L-62	1	1	1	1	0	Near	0–100	n/a	71.13236102	-78.3563
Rail	L-65	1	1	1		316	Far	101–1000	DF07-M	71.30001199	-79.1953
Rail	L-66	1	1	1		2,141*	Control	>1000	DF08-M	71.29453802	-79.1001
2014 Total	**12**	**12**	**11**	**10**	**4**						

Location	Site ID[1]	Soil	Lichen	Willow	Blueberry	Distance to PDA (m)[2]	Distance Category	Distance Class (m)	Associated Dust fall Site[3]	Latitude	Longitude
2013 Sampling											
Milne Port	L-01	1	1			0	Near	0–100	n/a	71.8850	-80.8911
Milne Port	L-02	1	1	1		3,269*	Control	>1000	DF03-P	71.8996	-80.7884
Milne Port	L-03	1	1		1	0	Near	0–100	n/a	71.8702	-80.8843
Tote Road	L-04	1	1	1		4,491*	Control	>1000	DF01-RN	71.6882	-80.5362
Tote Road	L-05	1	1	1		941	Far	101–1000	DF02-RN	71.6883	-80.5363
Tote Road	L-06	1	1	1		15	Near	0–100	DF03-RN	71.7186	-80.4473
Tote Road	L-07	1	1			25	Near	0–100	DF06-RN	71.7189	-80.4397
Tote Road	L-08	1	1	1		920	Far	101–1000	DF07-RN	71.7226	-80.4165
Tote Road	L-09	1	1	1		5,864*	Control	>1000	DF08-RN	71.7435	-80.2898
Tote Road	L-10	1		1		13,938*	Control	>1000	DF01-RR	71.2805	-80.245
Tote Road	L-12	1	1	1	1	941	Control	>1000	DF02-RN	71.7145	-80.4704
Tote Road	L-14	1	1			571	Far	101-1000	DF02-RS	71.3894	-79.8324
Tote Road	L-15	1	1		1	9	Near	0–100	DF03-RS	71.3967	-79.8228
Tote Road	L-16	1	1	1		1	Near	0–100	DF06-RS	71.3986	-79.8234
Tote Road	L-17	1	1	1		936	Far	101–1000	DF07-RS	71.4077	-79.8182
Tote Road	L-19	1		1		6,628*	Control	>1000	DF08-RS	71.4489	-79.7107
Tote Road	L-22	1		1		5,948*	Control	>1000	DF01-RS	71.3275	-79.8001
Mine Site	L-23	1	1		1	0	Near	0–100	DF01-M	71.3243	-79.3747
Mine Site	L-25	1	1	1		0	Near	0–100	DF03-M	71.3071	-79.2432
Rail	L-29	1	1	1		8,916*	Control	>1000	DF04-M	71.2196	-79.3276
2013 Total	**20**	**20**	**17**	**14**	**4**						

Location	Site ID[1]	Soil	Lichen	Willow	Blueberry	Distance to PDA (m)[2]	Distance Category	Distance Class (m)	Associated Dust fall Site[3]	Latitude	Longitude
2012 Sampling											
Tote Road	L-11	1	1			2,961*	Control	>1000	n/a	71.5627	-80.2147
Tote Road	L-13	1	1			8,595*	Control	>1000	n/a	71.3386	-80.2238
Tote Road	L-18	1	1			1,451*	Control	>1000	n/a	71.4112	-79.7980
Mine Site	L-21	1	1			15,485*	Control	>1000	n/a	71.2215	-79.7947
Mine Site	L-20	1	1			32,532*	Control	>1000	n/a	71.6457	-79.2153
Mine Site	L-24	1	1			129	Far	101–1000	n/a	71.3331	-79.3766
Mine Site	L-26	1	1			2,881*	Control	>1000	n/a	71.3391	-79.0935
Mine Site	L-27	1				2,448*	Control	>1000	n/a	71.3758	-79.2471
Mine Site	L-28	1	1			39,601*	Control	>1000	n/a	71.5403	-78.2296
Rail	L-30	1	1			2,015*	Control	>1000	n/a	71.2143	-78.9602
Rail	L-31	1	1			0	Near	0–100	n/a	71.2128	-78.8212
Rail	L-32	1	1			18,179*	Control	>1000	n/a	71.3204	-78.2655
Rail	L-33	1	1			20,033*	Control	>1000	n/a	71.0874	-79.2945
Rail	L-34	1	1			3,711*	Control	>1000	n/a	71.0966	-78.4454
Rail	L-35	1	1			0	Near	0–100	n/a	71.0946	-78.3073
Rail	L-36	1	1			3,409*	Control	>1000	n/a	71.0926	-78.1692
Rail	L-37	1	1			18,231*	Control	>1000	n/a	71.1990	-77.8488
Rail	L-38	1	1			24,241*	Control	>1000	n/a	71.1262	-77.5989
Rail	L-39	1	1			31,678*	Control	>1000	n/a	70.8877	-79.2012
Rail	L-40	1	1			3,742*	Control	>1000	n/a	70.8777	-78.3815
Rail	L-41	1	1			0	Near	0–100	n/a	70.8763	-78.2491
Rail	L-42	1	1			3,511*	Control	>1000	n/a	70.8733	-78.1138

Location	Site ID[1]	Soil	Lichen	Willow	Blueberry	Distance to PDA (m)[2]	Distance Category	Distance Class (m)	Associated Dust fall Site[3]	Latitude	Longitude
Rail	L-43	1	1			31,295*	Control	>1000	n/a	70.8590	-77.2928
Rail	L-44	1	1			30,423*	Control	>1000	n/a	70.7046	-79.0277
Rail	L-45	1	1			4,460*	Control	>1000	n/a	70.7023	-78.2643
Rail	L-46	1	1			318	Far	101–1000	n/a	70.6844	-78.1392
Rail	L-47	2	1			23,710*	Control	>1000	n/a	70.4932	-79.0189
Rail	L-48	1	1			198	Control	>1000	n/a	70.4844	-78.3384
Rail	L-49	1	1			3,021*	Far	101–1000	n/a	70.4813	-78.2232
Rail	L-50	1	1			25,141*	Control	>1000	n/a	70.4672	-77.4202
Rail	L-55	1	1			29,266*	Control	>1000	n/a	70.2890	-77.5545
Steensby Port	L-51	1	1			4,727*	Control	>1000	n/a	70.3491	-78.6164
Steensby Port	L-52	1	1			0	Near	0–100	n/a	70.3043	-78.4834
Steensby Port	L-53	1	1			1,944*	Control	>1000	n/a	70.3024	-78.3506
Steensby Port	L-54	1	1			3,588*	Control	>1000	n/a	70.2412	-78.3607
2012 Total	**35**	**36**	**34**	**0**	**0**	**13**					
Total (2012–2016)	**117**	**117**	**112**	**24**	**8**	**49 Control(*)**					

[1] Collection sites for 2012 and 2013 were relabelled following the 2013 field program to provide consistency between years and facilitate mapping; all results reported here are by the new Site ID with the exception of the lab results presented in Attachment 2 and 3 (refer to the 2013 Terrestrial Environment Annual Monitoring Report) where samples were sent to the lab under the original label - samples were labelled by the Original site label followed by a label for the sample type: "S" for soil, "L" for lichen, "W" for willow, and "B" for blueberry. For example: the sample label L-13.05-S01 would indicate Original site L-13.05 soil sample 01; the sample label L-13.11-W01 would indicate Original site L-13.11 willow sample 01.

[2] Control sites are labelled with an asterisk (*). Control sites are ≥1000 m to coincide with the dustfall monitoring program.

[3] Sites were considered 'associated' if they were within 60 m or less of each other; most sites were 0-12 m of each other; sites within 150 m of each another may be considered somewhat associated.

ATTACHMENT 4 LABORATORY RESULTS: METALS IN SOIL AND VEGETATION (2012-2016)

Table D-1. 2016 Soil metal analysis (n=50), sample sites L-68 to L-79.

Parameter[1]	CCME Agri[2]	CCME Ind[2]	L-68	L-69	L-70	L-71	L-72	L-73	L-74	L-75	L-76	L-77	L-78	L-79	RDL[3]
pH	6-8	6-8	5.47	5.92	5.44	5.54	5.42	5.53	5.48	5.51	5.46	5.78	5.59	5.25	N/A
Arsenic	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Cadmium	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Copper	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Lead	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Selenium	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Zinc	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

[1] Total metals (units mg/kg dry weight) unless otherwise indicated

[2] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)

[3] Reportable Detection Limit (RDL)

Table D-2. 2016 Soil metal analysis (n=50), sample sites L-80 to L-91.

Parameter[1]	CCME Agri[2]	CCME Ind[2]	L-80	L-81	L-82	L-83	L-84	L-85	L-86	L-87	L-88	L-89	L-90	L-91	RDL[3]
pH	6-8	6-8	5.47	6.96	6.57	6.99	7.38	7.73	7.91	5.90	5.85	6.55	7.15	7.56	N/A
Arsenic	0.50	0.50	<0.50	<0.50	<0.50	1.53	0.84	0.77	1.06	<0.50	<0.50	<0.50	<0.50	0.82	0.50
Cadmium	0.050	0.050	<0.050	<0.050	0.064	0.152	0.070	0.050	0.093	<0.050	<0.050	0.061	<0.050	0.065	0.050
Copper	0.50	0.50	<0.50	2.76	2.67	19.1	6.94	6.56	11.7	1.54	2.31	2.40	2.09	116	0.50
Lead	0.10	0.10	0.54	11.2	3.91	10.8	7.40	4.02	10.5	2.99	2.61	3.02	2.24	10.8	0.10
Selenium	0.50	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	1.0	1.0	1.2	6.4	11.8	29.7	24.4	13.8	18.5	7.1	8.3	11.7	7.9	26.7	1.0

[1] Total metals (units mg/kg dry weight) unless otherwise indicated

[2] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)

[3] Reportable Detection Limit (RDL)

Table D-3. 2016 Soil metal analysis (n=50), sample sites L-92 to L-104.

Parameter[1]	CCME Agri[2]	CCME Ind[2]	L-92	L-93	L-94	L-95	L-96	L-97	L-98	L-99	L-100	L-101	L-102	L-103	L-104	RDL[3]
pH	6-8	6-8	7.10	7.57	8.00	8.35	7.17	8.35	8.14	7.03	7.91	8.62	8.74	8.66	8.39	N/A
Arsenic	0.50	0.50	<0.50	<0.50	0.69	0.74	1.10	0.73	0.59	1.19	0.81	1.00	0.75	<0.50	<0.50	0.50
Cadmium	0.050	0.050	<0.050	0.074	<0.050	0.067	0.082	0.091	0.057	0.136	0.085	0.060	0.101	0.076	<0.050	0.050
Copper	0.50	0.50	2.02	3.69	5.72	4.13	5.27	11.1	4.13	8.49	5.85	5.25	4.56	3.17	1.55	0.50
Lead	0.10	0.10	3.69	3.48	7.72	4.09	6.50	4.46	4.32	8.31	7.27	5.22	4.52	3.55	1.82	0.10
Selenium	0.50	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	1.0	1.0	12.1	23.9	15.8	12.6	20.9	15.9	15.5	25.1	22.7	14.2	13.7	9.9	4.2	1.0

[1] Total metals (units mg/kg dry weight) unless otherwise indicated

[2] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)

[3] Reportable Detection Limit (RDL)

Table D-4. 2016 Soil metal analysis (n=50), sample sites L-105 to L-117.

Parameter[1]	CCME Agri[2]	CCME Ind[2]	L-105	L-106	L-107	L-108	L-109	L-110	L-111	L-112	L-113	L-114	L-115	L-116	L-117	RDL[3]
pH	6-8	6-8	7.58	8.68	5.66	6.69	6.56	7.10	7.33	6.70	7.10	8.06	6.99	5.72	6.49	N/A
Arsenic	0.50	0.50	0.89	0.83	1.17	0.53	<0.50	0.75	<0.50	0.87	0.57	0.56	<0.50	<0.50	1.20	0.50
Cadmium	0.050	0.050	0.121	0.064	<0.050	0.057	<0.050	<0.050	0.084	0.152	0.126	<0.050	0.060	0.070	0.108	0.050
Copper	0.50	0.50	9.60	3.55	2.96	5.53	2.65	3.42	2.99	16.9	5.96	3.97	3.01	0.52	8.05	0.50
Lead	0.10	0.10	4.41	2.98	2.65	3.86	1.73	4.16	2.83	6.62	4.56	4.34	3.45	0.85	6.09	0.10
Selenium	0.50	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	1.0	1.0	19.6	9.5	10.0	14.5	8.1	13.7	12.4	39.6	15.7	10.1	10.1	2.0	16.2	1.0

[1] Total metals (units mg/kg dry weight) unless otherwise indicated
[2] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)
[3] Reportable Detection Limit (RDL)

Table D-5. 2016 Lichen metal analysis (n=50), sample sites L-68 to L-81.

Parameter[1]	L-68	L-69	L-70	L-71	L-72	L-73	L-74	L-75	L-76	L-77	L-78	L-79	L-80	L-81	RDL[2]
Arsenic	0.193	0.352	0.166	0.243	0.146	0.191	0.233	0.104	0.110	0.071	0.216	0.165	0.135	0.113	0.050
Cadmium	0.054	0.038	0.048	0.080	0.041	0.029	0.035	0.025	0.026	0.026	0.028	0.028	0.042	0.045	0.010
Copper	4.06	5.34	2.96	5.22	3.38	3.87	4.09	2.11	1.87	1.14	4.29	3.80	3.33	2.15	0.050
Lead	2.24	2.58	1.43	6.04	2.56	2.81	2.98	1.26	0.932	0.571	1.70	1.76	1.60	1.25	0.010
Selenium	0.071	0.081	0.067	0.088	0.068	0.064	0.078	<0.050	0.061	<0.050	0.083	0.052	0.062	0.074	0.050
Zinc	16.0	18.0	15.0	22.2	18.0	16.5	17.9	13.5	16.0	9.35	19.7	15.9	18.1	14.8	0.20

[1] Total metals (units mg/kg dry weight) unless otherwise indicated
[2] Reportable Detection Limit (RDL)

Table D-6. 2016 Lichen metal analysis (n=50), sample sites L-82 to L-95.

Parameter[1]	L-82	L-83	L-84	L-85	L-86	L-87	L-88	L-89	L-90	L-91	L-92	L-93	L-94	L-95	RDL[2]
Arsenic	0.068	0.055	0.077	0.101	0.116	0.108	0.095	0.095	0.107	0.051	0.057	0.074	<0.050	<0.050	0.050
Cadmium	0.032	0.040	0.040	0.034	0.051	0.055	0.063	0.049	0.031	0.039	0.034	0.037	0.037	0.033	0.010
Copper	1.56	1.29	1.59	1.90	3.02	2.50	2.98	2.36	4.49	0.964	0.897	1.06	0.835	0.809	0.050
Lead	0.593	0.576	0.713	0.954	1.31	1.34	1.56	1.20	1.67	1.02	0.730	1.19	1.20	0.881	0.010
Selenium	<0.050	0.056	0.071	0.079	0.054	0.068	0.056	0.054	<0.050	0.065	0.061	0.056	0.058	<0.050	0.050
Zinc	11.1	13.5	10.8	11.2	11.1	14.3	15.3	14.2	15.5	11.6	9.90	11.0	10.7	11.6	0.20

[1] Total metals (units mg/kg dry weight) unless otherwise indicated
[2] Reportable Detection Limit (RDL)

Table D-7. 2016 Lichen metal analysis (n=50), sample sites L-96 to L-109.

Parameter[1]	L-96	L-97	L-98	L-99	L-100	L-101	L-102	L-103	L-104	L-105	L-106	L-107	L-108	L-109	RDL[2]
Arsenic	0.074	<0.050	0.072	0.076	0.068	0.055	<0.050	<0.050	<0.050	<0.050	0.060	<0.050	0.075	<0.050	0.050
Cadmium	0.038	0.024	0.050	0.043	0.035	0.036	0.045	0.021	0.031	0.031	0.034	0.044	0.037	0.086	0.010
Copper	0.821	0.680	0.874	0.843	0.785	0.739	0.877	0.797	0.764	0.932	0.772	0.875	0.753	0.806	0.050
Lead	1.23	0.532	1.19	1.46	0.902	0.931	0.785	0.510	0.414	0.401	0.446	0.286	0.836	0.411	0.010
Selenium	0.074	0.058	0.058	0.072	0.056	0.077	0.070	0.069	<0.050	0.051	0.051	0.057	<0.050	0.065	0.050
Zinc	9.16	8.26	11.4	9.00	7.85	7.16	10.3	7.70	11.0	12.7	12.1	15.3	6.47	15.2	0.20

[1] Total metals (units mg/kg dry weight) unless otherwise indicated
[2] Reportable Detection Limit (RDL)

Table D-8. 2016 Lichen metal analysis (n=50), sample sites L-110 to L-117.

Parameter[1]	L-110	L-111	L-112	L-113	L-114	L-115	L-116	L-117	RDL[2]
Arsenic	<0.050	<0.050	0.076	0.112	0.067	<0.050	0.071	0.066	0.050
Cadmium	0.095	0.072	0.114	0.166	0.039	0.036	0.057	0.088	0.010
Copper	0.900	0.888	1.30	1.03	1.11	1.03	1.22	1.83	0.050
Lead	0.566	0.279	1.41	1.73	1.03	0.563	1.12	1.10	0.010
Selenium	0.071	<0.050	0.115	0.100	0.066	<0.050	0.056	0.063	0.050
Zinc	18.0	18.5	22.4	19.5	9.08	12.2	13.9	19.6	0.20

[1] Total metals (units mg/kg dry weight) unless otherwise indicated
[2] Reportable Detection Limit (RDL)

Table D-9. 2014 Soil metal analysis (n=12), sample sites L-56 to L-67.

Parameter[1]	CCME Agri[2]	CCME Ind[2]	L-56	L-57	L-58	L-59	L-60	L-61	L-62	L-63	L-64	L-65	L-66	L-67	RDL[3]
pH	6-8	6-8	8.54	8.74	7.97	6.47	5.31	4.94	5.23	8.60	5.49	7.93	6.21	6.89	N/A
Arsenic	12	12	1.01	1.82	1.01	0.86	0.61	<0.50	0.59	0.90	1.86	0.81	0.83	<0.50	0.50
Cadmium	1.4	22	0.119	0.147	<0.050	<0.050	<0.050	<0.050	0.098	0.150	<0.050	<0.050	0.158	<0.050	0.050
Copper	63	91	4.55	4.44	1.92	3.43	2.42	2.34	5.31	5.82	5.66	4.85	8.79	0.86	0.50
Lead	70	600	4.73	4.43	1.97	4.91	2.12	1.76	5.58	5.16	2.77	4.84	4.89	1.40	0.10
Selenium	1	2.9	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	200	360	22.7	10.2	5.6	19.4	8.4	9.8	23.9	16.9	12.5	12.3	16.3	4.1	1.0

[1] Total metals (units mg/kg dry weight) unless otherwise indicated
[2] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)
[3] Reportable Detection Limit (RDL)

Table D-10. 2014 Vegetation metal analysis (n=25), sample sites L-56 to L-60.

Parameter[1]	L-56 (lichen)	L-56 (willow)	L-57 (willow)	L-58 (lichen)	L-59 (lichen)	L-59 (willow)	L-60 (lichen)	L-60 (willow)	L-60 (blueberry)	RDL[2]
Arsenic	0.187	<0.050	<0.050	0.225	<0.050	<0.050	0.104	<0.050	<0.050	0.050
Cadmium	0.094	0.757	0.515	0.042	0.054	0.533	0.099	0.574	0.265	0.010
Copper	2.12	9.36	10.3	1.83	0.870	12.5	3.28	11.2	12.8	0.050
Lead	2.60	0.090	0.089	1.81	0.399	0.088	0.970	0.279	0.336	0.010
Selenium	0.142	<0.050	<0.050	0.095	<0.050	<0.050	0.055	<0.050	<0.050	0.050
Zinc	16.2	74.8	90.2	14.2	12.6	188	28.8	352	118	0.20

[1] Total metals (units mg/kg dry weight) unless otherwise indicated

[2] Reportable Detection Limit (RDL)

Table D-11. 2014 Vegetation metal analysis (n=25), sample sites L-61 to L-63.

Parameter[1]	L-61 (lichen)	L-61 (willow)	L-61 (blueberry)	L-62 (lichen)	L-62 (willow)	L-62 (blueberry)	L-63 (lichen)	L-63 (willow)	RDL[2]
Arsenic	0.053	<0.050	<0.050	0.104	<0.050	<0.050	<0.050	<0.050	0.050
Cadmium	0.082	0.441	0.412	0.100	0.488	0.396	0.048	0.231	0.010
Copper	3.82	10.7	10.8	3.67	9.31	11.3	2.14	8.89	0.050
Lead	0.675	0.084	0.056	2.19	0.034	0.083	0.681	0.036	0.010
Selenium	0.071	<0.050	<0.050	0.096	<0.050	<0.050	0.069	<0.050	0.050
Zinc	33.2	214	77.9	25.4	114	52.6	18.9	188	0.20

[1] Total metals (units mg/kg dry weight) unless otherwise indicated

[2] Reportable Detection Limit (RDL)

Table D-12. 2014 Vegetation metal analysis (n=25), sample sites L-64 to L-67.

Parameter[1]	L-64 (lichen)	L-65 (lichen)	L-65 (willow)	L-66 (lichen)	L-66 (willow)	L-67 (lichen)	L-67 (willow)	L-67 (blueberry)	RDL[2]
Arsenic	1.10	0.108	<0.050	0.053	<0.050	0.094	<0.050	<0.050	0.050
Cadmium	0.263	0.095	0.832	0.090	0.342	0.042	0.504	0.277	0.010
Copper	3.18	2.24	13.4	1.27	7.63	1.40	6.99	11.3	0.050
Lead	6.71	1.42	0.089	0.749	0.077	1.05	0.155	0.058	0.010
Selenium	0.197	0.079	<0.050	0.063	<0.050	<0.050	<0.050	<0.050	0.050
Zinc	23.8	15.9	83.6	19.4	103	9.82	118	83.3	0.20

[1] Total metals (units mg/kg dry weight) unless otherwise indicated
[2] Reportable Detection Limit (RDL)

Table D-13. 2013 Soil metal analysis (n=20), sample sites L-01 to L-10 (new site ID)[1].

Parameter[2]	CCME Agri[3]	CCME Ind[3]	L-01	L-02	L-03	L-04	L-05	L-06	L-07	L-08	L-09	L-10	RDL[4]
pH	6-8	6-8	8.27	8.52	6.35	8.53	8.59	8.60	8.32	7.65	6.05	8.64	0.010
Arsenic	12	12	<0.50	0.57	<0.50	0.90	0.78	1.19	1.25	0.60	<0.50	<0.50	0.50
Cadmium	1.4	22	<0.050	0.080	0.081	0.134	0.066	0.075	0.061	<0.050	<0.050	0.250	0.050
Copper	63	91	1.56	4.20	6.17	8.38	4.45	6.03	7.03	3.99	2.03	6.14	0.50
Lead	70	600	1.64	2.92	5.60	6.97	3.89	5.26	6.51	2.30	2.94	7.74	0.10
Selenium	1	2.9	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	200	360	4.1	11.4	34.3	15.9	8.1	11.6	16.2	6.2	6.9	16.4	1.0

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)
[4] Reportable Detection Limit (RDL)

Table D-14. 2013 Soil metal analysis (n=20), sample sites L-12 to L-29 (new site ID)[1].

Parameter[2]	CCME Agri[3]	CCME Ind[3]	L-12	L-14	L-15	L-16	L-17	L-19	L-22	L-23	L-25	L-29	RDL[4]
pH	6-8	6-8	7.59	5.29	5.67	6.70	6.28	7.03	7.10	6.54	7.42	5.55	0.010
Arsenic	12	12	0.71	1.26	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.61	<0.50	0.50
Cadmium	1.4	22	0.063	0.080	<0.050	<0.050	<0.050	0.073	0.252	<0.050	0.102	<0.050	0.050
Copper	63	91	5.04	3.97	0.96	1.17	1.77	4.51	5.82	2.41	7.27	2.73	0.50
Lead	70	600	3.16	2.11	0.82	0.89	1.29	1.96	4.95	3.31	4.55	3.22	0.10
Selenium	1	2.9	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	200	360	8.9	17.0	3.2	2.3	4.4	7.5	15.9	11.4	17.1	16.5	1.0

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)
[4] Reportable Detection Limit (RDL)

Table D-15. 2013 Vegetation metal analysis (n=35), sample sites L-01 to L-07 (new site ID)[1].

Parameter [2]	L-01 (lichen)	L-02 (lichen)	L-02 (willow)	L-03 (lichen)	L03 (blueberry)	L-04 (lichen)	L-04 (willow)	L-05 (lichen)	L-05 (willow)	L-06 (lichen)	L-06 (willow)	L-07 (willow)	RDL [3]
Arsenic	0.145	0.075	<0.050	0.081	<0.050	0.153	<0.050	0.055	<0.050	0.192	<0.050	0.215	0.050
Cadmium	0.032	0.059	0.447	0.046	0.841	0.039	0.295	0.025	0.227	0.038	0.441	0.032	0.010
Copper	1.22	0.816	5.81	1.23	12.8	1.15	6.85	0.691	4.88	1.16	6.52	1.53	0.050
Lead	0.856	0.906	0.024	0.817	0.119	1.18	0.066	0.427	0.017	1.11	0.029	1.06	0.010
Selenium	0.066	0.066	<0.050	0.065	<0.050	0.062	<0.050	<0.050	<0.050	0.082	<0.050	0.080	0.050
Zinc	10.4	9.40	92.9	12.1	251	9.74	82.0	7.14	111	8.57	133	9.84	0.20

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Reportable Detection Limit (RDL)

Table D-16. 2013 Vegetation metal analysis (n=35), sample sites L-08 to L-16 (new site ID)[1].

Parameter [2]	L-08 (lichen)	L-08 (willow)	L-09 (lichen)	L-09 (willow)	L-10 (willow)	L-12 (lichen)	L-12 (willow)	L-12 (blueberry)	L-14 (lichen)	L-15 (blueberry)	L-15 (lichen)	L-16 (lichen)	RDL [3]
Arsenic	0.112	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.060	<0.050	0.121	0.175	0.050
Cadmium	0.045	0.162	0.174	0.464	0.631	0.067	0.380	0.447	0.025	0.764	0.047	0.084	0.010
Copper	1.02	6.63	0.834	8.38	17.6	0.798	11.6	12.2	0.764	10.6	2.30	2.65	0.050
Lead	0.783	0.017	0.699	0.024	0.076	0.809	0.066	0.350	0.218	0.173	0.526	2.57	0.010
Selenium	0.061	<0.050	0.055	<0.050	<0.050	0.056	<0.050	<0.050	<0.050	<0.050	0.064	0.065	0.050
Zinc	10.8	138	20.6	194	133	16.0	396	121	12.3	369	21.0	20.5	0.20

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1

[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Reportable Detection Limit (RDL)

Table D-17. 2013 Vegetation metal analysis (n=35), sample sites L-16 to L-29 (new site ID)[1]

Parameter [2]	L-16 (willow)	L-17 (lichen)	L-17 (willow)	L-19 (willow)	L-22 (willow)	L-23 (lichen)	L-23 (blueberry)	L-24 (blueberry)	L-25 (lichen)	L-25 (willow)	L-29 (willow)	L-29 (willow)	RDL [3]
Arsenic	<0.050	0.075	<0.050	<0.050	<0.050	0.244	<0.050	0.244	0.089	<0.050	<0.050	<0.050	0.050
Cadmium	0.312	0.048	0.374	0.772	0.657	0.136	0.940	0.136	0.166	3.65	0.189	1.08	0.010
Copper	12.0	1.28	7.57	8.28	10.0	3.44	15.7	3.44	1.71	9.32	0.975	10.3	0.050
Lead	0.151	1.04	0.125	0.093	0.076	3.47	0.274	3.47	1.94	0.041	0.620	0.046	0.010
Selenium	<0.050	0.057	<0.050	<0.050	<0.050	0.090	<0.050	0.090	0.093	<0.050	0.058	<0.050	0.050
Zinc	131	11.7	70.0	73.5	208	20.4	65.8	20.4	19.2	242	29.1	221	0.20

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Reportable Detection Limit (RDL)

Table D-18. 2012 Soil metal analysis (n=36), sample sites L-11 to L-30 (new site ID)[1].

Parameter[2]	CCME Agri[3]	CCME Ind[3]	L-11	L-13	L-18	L-20	L-21	L-24	L-26	L-27	L-28	L-30	RDL[4]
pH	6–8	6–8	8.35	8.57	7.45	5.90	4.83	6.83	6.64	7.59	5.94	5.66	0.010
Arsenic	12	12	1.43	<0.50	4.14	<0.50	<0.50	<0.50	<0.50	0.91	<0.50	<0.50	0.50
Cadmium	1.4	22	0.132	<0.050	<0.050	0.055	<0.050	0.066	0.072	0.275	0.103	<0.050	0.050
Copper	63	91	8.77	0.67	4.53	4.29	2.21	2.78	3.58	10.2	10.1	0.81	0.50
Lead	70	600	7.85	1.18	1.93	4.13	4.03	2.02	3.02	6.83	4.75	0.65	0.10
Selenium	1	2.9	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	200	360	13.9	2.4	6.6	15.9	16.9	10.5	8.1	23.1	39.1	2.1	1.0

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1

[2] Total metals (units mg/kg dry weight) unless otherwise indicated

[3] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)

[4] Reportable Detection Limit (RDL)

Table D-19. 2012 Soil metal analysis (n=36), sample sites L-31 to L-40 (new site ID)[1].

Parameter[2]	CCME Agri[3]	CCME Ind[3]	L-31	L-32	L-33	L-34	L-35	L-36	L-37	L-38	L-39	L-40	RDL[4]
pH	6–8	6–8	5.19	6.02	6.62	7.60	8.38	5.21	5.64	5.55	6.05	5.15	0.010
Arsenic	12	12	<0.50	<0.50	<0.50	1.03	1.23	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Cadmium	1.4	22	<0.050	0.241	<0.050	<0.050	0.164	0.073	0.180	0.061	0.097	<0.050	0.050
Copper	63	91	2.00	5.46	1.31	5.22	3.93	8.74	3.95	6.68	3.75	2.82	0.50
Lead	70	600	3.15	5.16	2.27	5.55	6.23	5.42	3.16	5.25	3.91	2.27	0.10
Selenium	1	2.9	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	200	360	10.6	18.2	10.0	18.9	14.1	26.7	15.7	27.5	16.2	17.1	1.0

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)
[4] Reportable Detection Limit (RDL)

Table D-20. 2012 Soil metal analysis (n=36) sample sites L-41 to L-48 (new site ID)[1].

Parameter[2]	CCME Agri[3]	CCME Ind[3]	L-41	L-42	L-43	L-44	L-45	L-46	L-47[4]	L-47[4]	L-48	RDL[5]
pH	6–8	6–8	5.10	5.45	5.41	4.92	5.59	4.89	4.58	7.80	4.80	0.010
Arsenic	12	12	<0.50	<0.50	<0.50	<0.50	<0.50	2.93	<0.50	1.06	<0.50	0.50
Cadmium	1.4	22	<0.050	0.060	0.126	<0.050	0.255	<0.050	0.054	<0.050	0.275	0.050
Copper	63	91	1.15	3.96	3.11	1.51	4.16	43.0	10.3	6.65	48.4	0.50
Lead	70	600	2.15	5.12	4.36	4.08	6.06	31.7	1.42	5.41	15.0	0.10
Selenium	1	2.9	<0.50	<0.50	<0.50	<0.50	<0.50	0.51	<0.50	<0.50	<0.50	0.50
Zinc	200	360	12.1	19.0	16.9	11.7	13.1	118	21.9	18.7	93.4	1.0

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)
[4] Two soil samples were taken from sample site L-47
[5] Reportable Detection Limit (RDL)

Table D-21. 2012 Soil metal analysis (n=36) sample sites L-49 to L-55 (new site ID)[1].

Parameter[2]	CCME Agri[3]	CCME Ind[3]	L-49	L-50	L-51	L-52	L-53	L-54	L-55	RDL[4]
pH	6–8	6–8	6.17	5.07	6.40	4.98	5.34	5.38	8.81	0.010
Arsenic	12	12	<0.50	<0.50	<0.50	<0.50	0.51	<0.50	<0.50	0.50
Cadmium	1.4	22	0.150	<0.050	<0.050	<0.050	0.128	<0.050	<0.050	0.050
Copper	63	91	13.0	6.73	8.60	3.04	21.3	9.19	3.10	0.50
Lead	70	600	5.85	4.29	3.36	5.93	8.23	3.22	2.03	0.10
Selenium	1	2.9	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Zinc	200	360	22.8	13.4	18.4	24.5	46.0	18.1	10.2	1.0

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Agriculture and Industrial Soil Quality Guidelines provided by the Canadian Council of Ministers of the Environment (CCME)
[4] Reportable Detection Limit (RDL)

Table D-22. 2012 Vegetation metal analysis (n=34), sample sites L-11 to L-32 (new site ID)[1].

Parameter[2]	L-11 (lichen)	L-13 (lichen)	L-18 (lichen)	L-20 (lichen)	L-21 (lichen)	L-24 (lichen))	L-26 (lichen)	L-28 (lichen)	L-30 (lichen)	L-31 (lichen)	L-32 (lichen)	RDL[3]
Arsenic	<0.050	0.112	<0.050	0.123	<0.050	<0.050	0.234	0.122	<0.050	0.066	0.181	0.050
Cadmium	0.068	0.064	0.044	0.241	0.116	0.040	0.192	0.178	0.045	0.117	0.182	0.010
Copper	0.941	1.23	0.661	1.14	0.738	0.928	1.79	1.10	0.628	0.750	1.81	0.050
Lead	0.539	1.76	0.391	2.93	0.784	0.751	4.29	2.57	0.609	1.38	1.85	0.010
Selenium	0.071	<0.050	<0.050	0.075	<0.050	0.050	0.105	0.077	<0.050	0.079	0.061	0.050
Zinc	15.3	12.2	12.4	14.1	19.8	9.10	11.8	13.6	10.4	13.1	28.3	0.20

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Reportable Detection Limit (RDL)

Table D-23. 2012 Vegetation metal analysis (n=34), sample sites L-33 to L-43 (new site ID)[1].

Parameter[2]	L-33 (lichen)	L-34 (lichen)	L-35 (lichen)	L-36 (lichen)	L-37 (lichen)	L-38 (lichen)	L-39 (lichen)	L-40 (lichen)	L-41 (lichen)	L-42 (lichen)	L-43 (lichen)	RDL[3]
Arsenic	<0.050	<0.050	<0.050	<0.050	0.125	0.125	<0.050	<0.050	0.060	0.071	0.154	0.050
Cadmium	0.054	0.039	0.045	0.046	0.297	0.203	0.046	0.150	0.123	0.240	0.144	0.010
Copper	0.747	0.589	0.774	0.760	0.951	0.574	0.894	0.740	0.837	0.899	0.935	0.050
Lead	0.226	0.277	0.302	0.411	4.44	3.19	0.390	1.11	0.882	1.30	2.21	0.010
Selenium	<0.050	<0.050	<0.050	<0.050	0.106	0.075	<0.050	0.066	0.056	<0.050	0.065	0.050
Zinc	15.7	11.0	15.8	15.4	15.4	11.7	23.8	24.0	21.4	29.5	13.4	0.20

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1
[2] Total metals (units mg/kg dry weight) unless otherwise indicated
[3] Reportable Detection Limit (RDL)

Table D-24. 2012 Vegetation metal analysis (n=34), sample sites L-44 toL-55 (new site ID)[1].

Parameter[2]	L-44 (lichen)	L-45 (lichen)	L-46 (lichen)	L-47 (lichen)	L-48 (lichen)	L-49 (lichen)	L-50 (lichen)	L-51 (lichen)	L-52 (lichen)	L-53 (lichen)	L-54 (lichen)	L-55 (lichen)	RDL[3]
Arsenic	0.066	0.092	0.508	0.067	0.109	0.096	0.061	<0.050	0.054	0.091	0.075	0.061	0.050
Cadmium	0.127	0.185	0.234	0.079	0.050	0.107	0.136	0.070	0.079	0.115	0.114	0.050	0.010
Copper	0.962	1.28	1.53	0.505	2.03	1.24	0.818	0.992	1.12	0.718	1.13	1.41	0.050
Lead	1.04	1.68	1.71	1.14	0.545	1.57	1.74	0.491	0.793	2.08	1.74	0.695	0.010
Selenium	0.102	0.072	0.071	0.088	0.071	0.140	0.075	0.067	0.083	0.111	0.119	0.053	0.050
Zinc	14.7	20.3	14.9	8.57	15.8	11.1	11.8	18.0	13.6	9.48	11.9	14.7	0.20

[1] Collection sites were re-labelled following the 2013 field program to provide consistency between years and facilitate mapping; the lab results reported here are by the new Site ID and can be referenced to the Original Site ID in the 2013 Annual Terrestrial Monitoring Report, Table 6, Section 2.2.1

[2] Total metals (units mg/kg dry weight) unless otherwise indicated

[3] Reportable Detection Limit (RDL)

ATTACHMENT 5 EXOTIC PLANT SPECIES KNOWN TO NUNAVUT

Table E-1. Exotic plant species known to Nunavut, provided by the Government of Nunavut, 2010.

Common Name	Species Name
Common barley	*Hordeum vulgare*
Common dandelion	*Taraxacum officinale*
Common plantain	*Plantago major*
Field pennycress	*Thlaspi arvense*
Field sow-thistle	*Sonchus arvensis*
Oxeye daisy	*Leucanthemum vulgare*
Opium poppy	*Papaver somniferum*
Prostrate knotweed	*Polygonum aviculare*
Redroot amaranth	*Amaranthus retroflexus*
Shepherd's purse	*Capsella bursa-pastoris*
Spreading alkali grass	*Puccinellia distans*
Tufted vetch	*Vicia cracca*
Wild caraway	*Carum carvi*
Yellow rocket	*Barbarea vulgaris*

*Personal communication with J. Saarela at the Museum of Nature on 13 November 2014 determined that foxtail barley (*Hordeum jubatum*) is the only known exotic species on Baffin Island. A few plants were found in Kimmirut, Nunavut in 2012 where it is not common, but likely persists.

ATTACHMENT 6 BAFFINLAND FIELD GUIDE TO EXOTIC PLANT SPECIES IDENTIFICATION

Baffinland Field Guide to Exotic Plant Species

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INTRODUCTION

This guide was developed to assist field personnel in the identification of potential exotic and invasive plant species associated with the Mary River Project. Plant species highlighted within this field guide are based on a list of exotic species provided by the Government of Nunavut from 2010. Although there are not many exotic plant species currently known in the territory of Nunavut, there are species that have been identified and must be recorded to prevent further spread. Positive identification of exotic and invasive plant species will depend on the level of basic botanical knowledge of the identifier. Note that species listed in this guide may appear slightly different (e.g., less erect and more prostrate), given the harsh climatic conditions in the Arctic.

The Nunavut Wildlife Act (2008) states that, "no person shall release a member of a species into a habitat in which that species does not belong or never naturally occurred", given that such action can lead to environmental, economic and social harm. The World Conservation Union states that invasive species are the second largest threat to ecosystems and biodiversity across the globe, next to habitat loss (IUCN 2011). To help categorize plant species the following terms are provided:

Native: Those species which are indigenous to the area where they are found growing (NatureServe Explorer 2009).

Weed: A general term use to describe a species that is either native or non-native (e.g., exotic) and is growing in an area where it is not wanted (Royer and Dickinson 1999).

Exotic: Species that are found outside of their natural range, often because of human activity. Exotic species are also known as alien, foreign, introduced, non-indigenous or non-native (BC Conservation Data Center 2013). These species may not pose an immediate risk; however, some can become invasive (YISC 2013).

Invasive: Species that are not native (alien, exotic, introduced etc.) to an ecosystem and have the potential to pose negative impacts to the environment, economy and social realms by out-competing native species for resources with the potential for hybridization (NatureServe 2010). The Yukon Invasive Species Council (2013) states that "the term 'invasive' is reserved for the most aggressive species that reproduce rapidly and cause major changes to the areas where they become established".

Noxious: Species which are typically non-native to the habitat where they have become established and do not have any natural predators or pathogens to keep them in check. Noxious weeds are invasive plants that are typically designated under legislation (e.g., Weed Act), that imposes a duty on all land occupiers to control invasive plants (Ministry of Agriculture 2013).

ACKNOWLEDGEMENTS

We would like to sincerely acknowledge and thank the following references and flora used primarily to compile this field guide: *Weeds of Canada and the northern United States* (Royer and Dickinson 1999), *The Illustrated Flora of British Columbia* (Douglas et al. 1998 to 2002), Electronic Atlas of the Flora of British Columbia (EFlora BC 2013), United States Department of Agriculture Natural Resource Conservation Service (USDA 2003), NatureServe Canada (2013) and NatureServe Explorer (2009).

We are also very thankful to those individuals who permitted the use of their photographs in this field guide, particularly Allan Carson, Diane Williamson, DND ASU Chilliwack, Janet Novak, Jamie Fenneman, Jim Lindsey, Jim Riley, Maurice Goguen, Yuri Pirogov, and Yuri S. Lee, Tom Heutte and Bugwood.org, Alfred Cook.

AUTHORSHIP

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Mike Setterington, R.P. Bio., CWB ....Senior Review

Wild Caraway
Carum carvi

General: A biennial herb belonging to the Carrot Family (Apiaceae) that was originally introduced to Canada from Eurasia. This plant forms from a taproot producing a single stem at the base of the plant, branching above and ranging in size from 0.3-1 m tall.

Leaves: 'Carrot-like' leaves. The lower leaves are between 8-17 cm long, stalked and pinnately divided into threadlike segments. Upper leaves are similar but reduced in size.

Flowers: The flowers are small, white and are terminally arranged at the top of the plant in umbrella-like clusters of 7-14 branches or spokes.

Fruits: Oblong-elliptic in shape, longer than wide with longitudinal lines, 3-4 mm long and scented.

Habitat: Generally found in fields and disturbed waste places.

Distribution: Within Canada wild caraway is known from BC, AB, SK, MB, ON, QC, NB, NS, PE, NF and NU.

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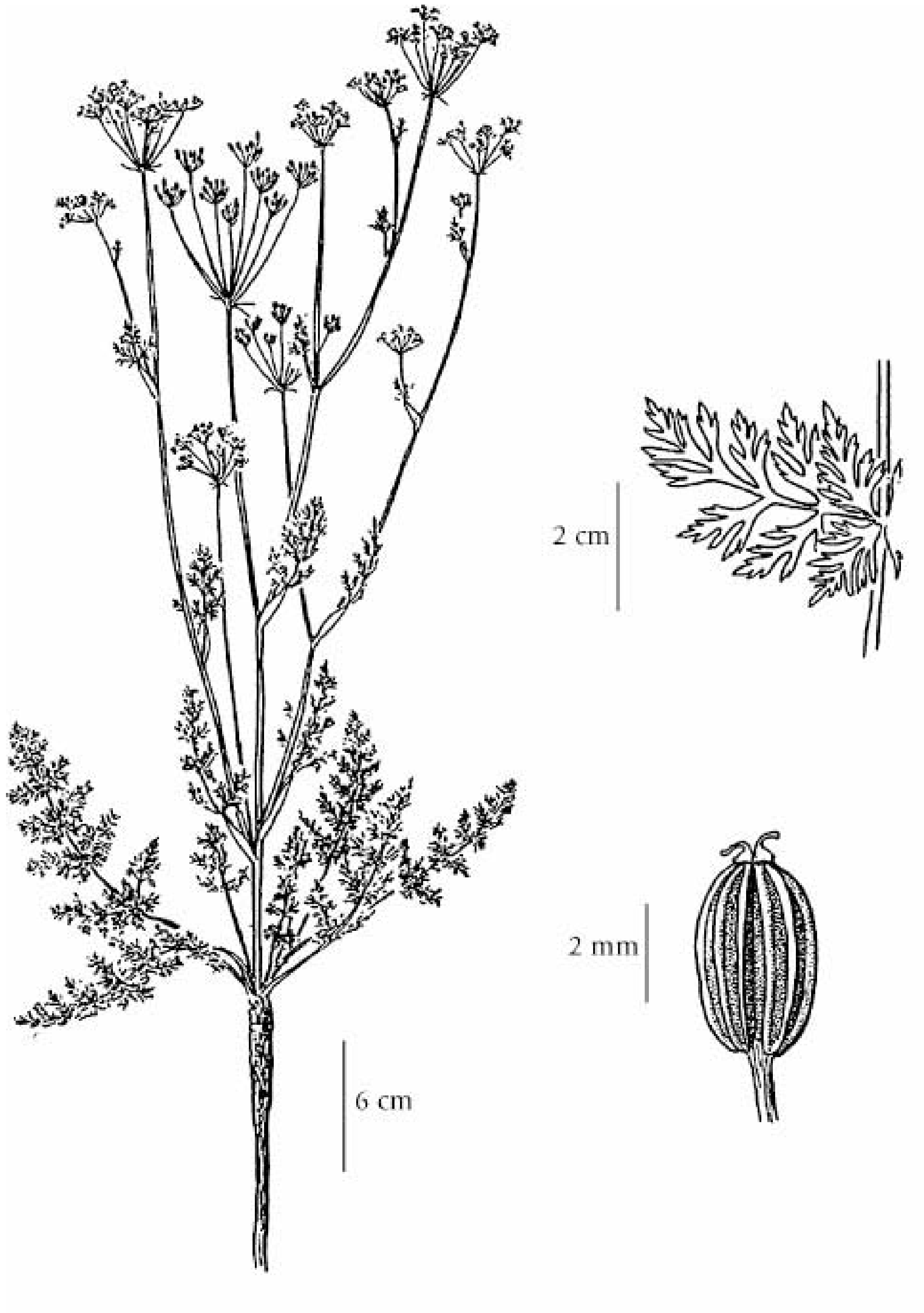

Carum carvi

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Common Dandelion
Taraxacum officinale

General: A perennial herb belonging to the Aster Family (Asteraceae) that is found worldwide and was originally introduced to Canada from Europe. The common dandelion is an early spring flowering plant that forms from a long, thick taproot producing erect leafless flowering stems that are hollow and exude milky juice when broken, ranging in size from 5-60 cm tall.

Leaves: Leaves are basal 5-40 cm long and 1-10 cm wide with an overall lance shape, pinnately lobed with coarse triangular lobes and entire to mostly toothed margins. The leaf stalk is generally winged near the base and generally <u>glabrous but can be hairy</u>. No stem leaves.

Flowers: Big yellow ray flowers that are strap shaped and found solitary at the top of a leafless stem. The involucral bracts subtending the yellow ray flowers are a key diagnostic feature for identification. Bracts are in 2 rows with the <u>outer row reflexed</u> or pointing back on itself.

Fruits: The seeds are called achenes, about 3-4 mm long (not including the long beak) and are green-brown to grey or straw coloured with sharp ribs. The achene is attached to a white pappus of fuzzy bristles that assist in wind dispersal.

Habitat: Disturbed areas, such as roadsides, fields, lawns, gardens and pastures.

Distribution: Within Canada common dandelion is known from all provinces and territories.

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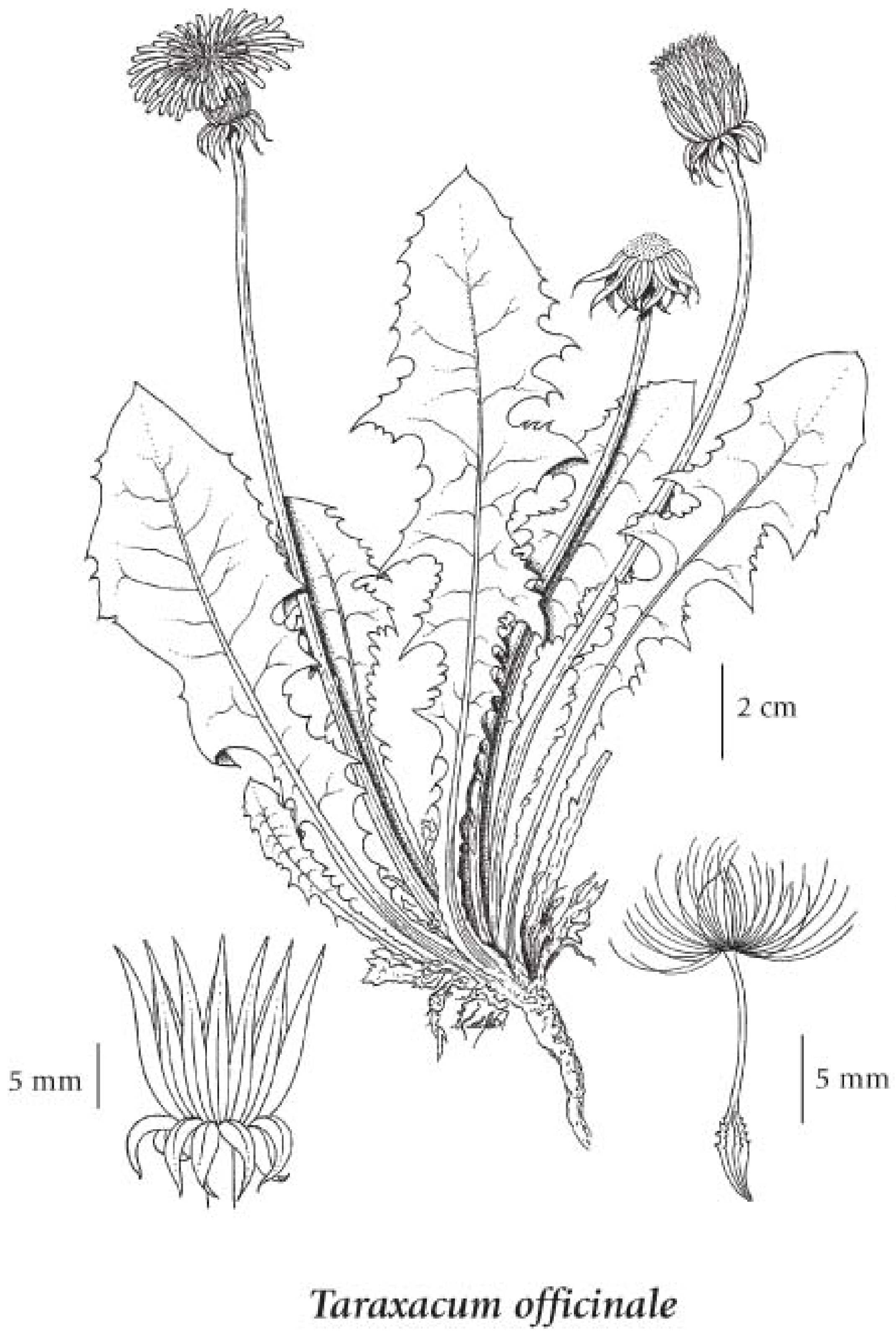

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Field Sow Thistle
Sonchus arvensis

General: A perennial herb belonging to the Aster Family (Asteraceae) that was originally introduced to Canada from Eurasia. Field sow thistle forms from long vertical and horizontal (rhizome) roots producing erect leafy flowering stems that are hollow and exude milky juice when broken, ranging in size from 0.4-2 m tall.

Leaves: No basal leaves. Stem leaves are alternately arranged, pinnately or deeply lobed with prickly margins, about 6-40 cm long and 2-15 cm wide. Leaf bases clasp the stem.

Flowers: Big yellow ray flowers, 3-5 cm wide, that are strap shaped with several flowers at the top of each leafy stem. The involucral bracts are lance shaped and are a key diagnostic feature to identifying two possible sub-species that differ morphologically: *Sonchus arvensis* ssp. *arvensis* which has involucre bracts and flowering stalks (peduncles) with black gland-tipped hairs and *Sonchus arvensis* ssp. *uliginosus* which is glabrous and lacks gland-tipped hairs on its involucre bracts and flowering stalks.

Fruits: The seeds are called achenes, about 2.5-3.5 mm long and are longitudinally ribbed with a white pappus of fuzzy bristles that assist in wind dispersal.

Habitat: Disturbed areas, such as roadsides, fields, lawns, gardens and pastures.

Distribution: Within Canada field sow thistle is known from all provinces and territories.

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Sonchus arvensis ssp. *uliginosus*
© Yuri Pirogov

Sonchus arvensis ssp. *arvensis*
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Oxeye Daisy
Leucanthemum vulgare

General: A perennial herb belonging to the Aster Family (Asteraceae) that was originally introduced to Canada from Europe. Oxeye daisy forms from horizontal creeping roots (rhizome) producing erect leafy flowering stems that are sparingly branched, glabrous and range in size from 10-100 cm tall.

Leaves: Both basal and stem leaves are present. All leaves are alternately arranged on the stem. Basal leaves are egg to spoon-shaped, stalked with wavy lobed to toothed margins ranging in size from 4-15 cm long. Stem leaves are smaller in size and are unstalked without obvious lobes or teeth on the margins, generally entire.

Flowers: Flowers are characteristic daisy-like heads. Flower heads are made up of disc (yellow center) and ray flowers (12-20 mm long white outer part), which are solitary at the ends of branches. Involucral bracts subtending the flower head are layered like shingles on a roof 7-11 mm long, lance shaped, smooth and have an obvious dark brown to black outline.

Fruits: The seeds are called achenes, which are cylindrical, black and have 10 longitudinal ribs. Achenes are attached at the base of each disc flower.

Habitat: Disturbed areas, such as roadsides, waste places, fields, lawns, gardens and pastures.

Distribution: Within Canada oxeye daisy is known from all provinces and territories.

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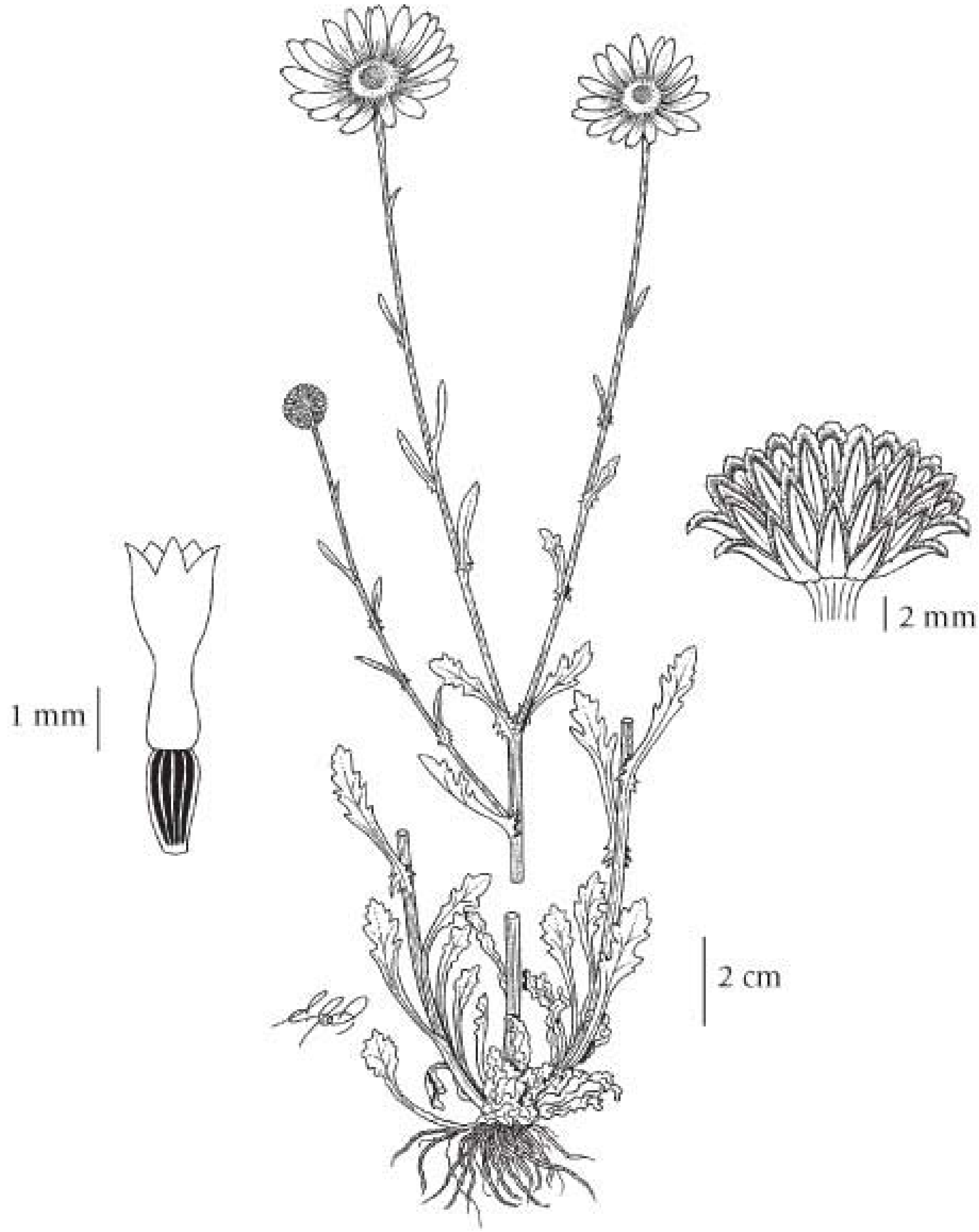

Leucanthemum vulgare

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Field Pennycress
Thlaspi arvense

General: An annual herb belonging to the Mustard Family (Brassicaceae) that was originally introduced to Canada from Eurasia. Field pennycress forms from a taproot producing erect leafy stems that are branched, glabrous and range in size from 10-50 cm tall.

Leaves: Both basal and stem leaves are present, although basal leaves are few and soon dropping, oblanceolate, 2-6 mm long and 1-2 cm wide, short stalked and smooth with strong wavy margins. Upper leaves are smaller and alternately arranged on the stem with ear like lobes that clasp the stem, lance to oblanceolate in shape, with wavy lobed to toothed margins and glabrous.

Flowers: Flowers are arranged in terminal elongating racemes, 7-15 mm long, with small white petal flowers about 3-4 mm long.

Fruits: The seeds are called silicles, which are <u>oval to nearly heart shaped pods</u>, 10-17 mm long, 9-15 mm wide and strongly flattened with a deep notch at the apex and winged margins. Within each pod there are black compressed ovoid seeds about 2 mm long with concentric ridges.

Habitat: Disturbed areas, such as roadsides, waste places and fields.

Distribution: Within Canada field pennycress is known from all provinces and territories.

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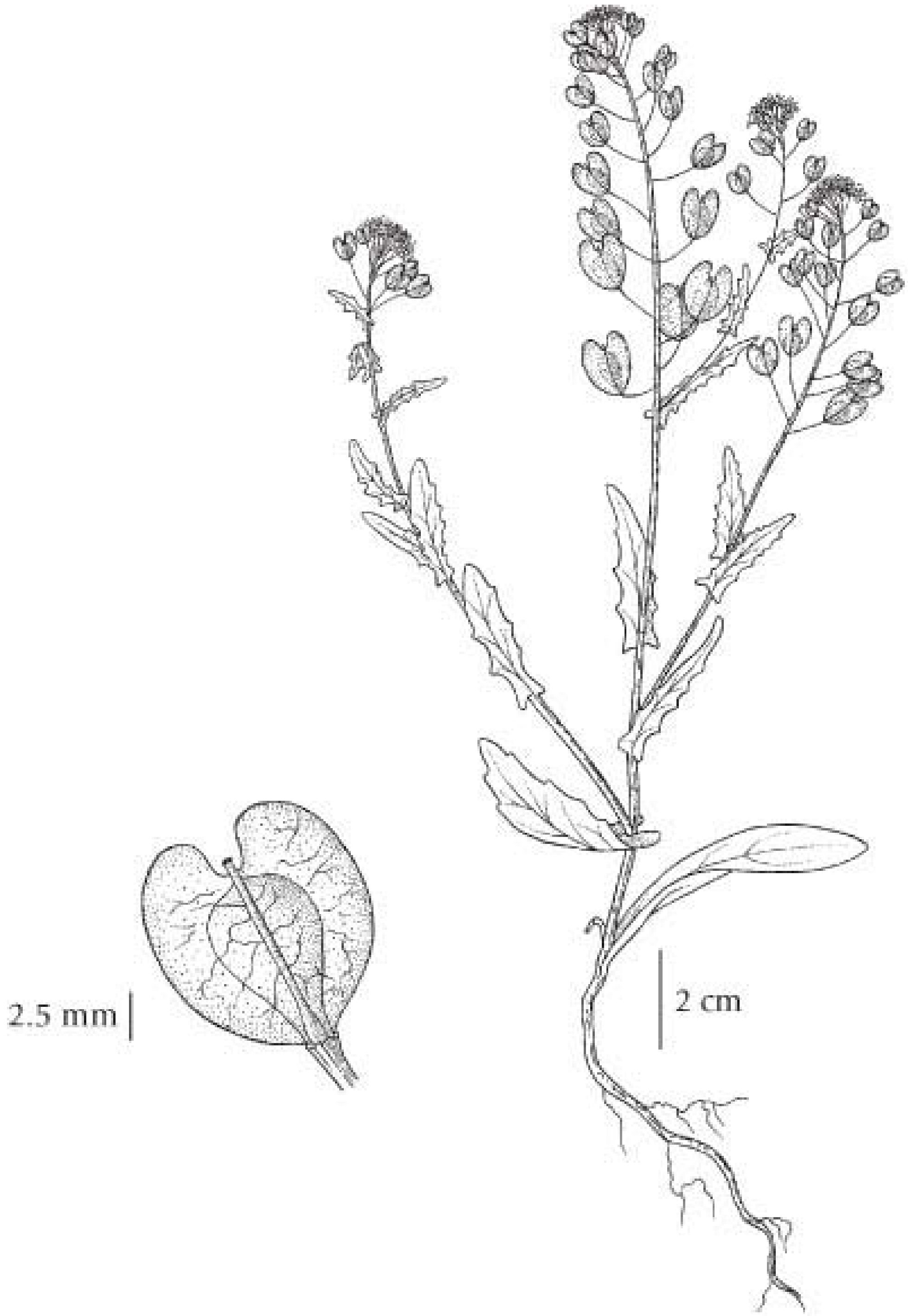

Thlaspi arvense

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Shepherd's Purse
Capsella bursa-pastoris

General: An annual herb belonging to the Mustard Family (Brassicaceae) that was originally introduced to Canada from Eurasia. Shepherd's purse forms from a taproot producing erect simple to branched stems with simple to starlike hairs, ranging in size from 10-80 cm tall.

Leaves: Both basal and stem leaves are present. Basal leaves are in a rosette at the base of the plant, oblanceolate, stalked, 3-15 cm long, up to 4 cm wide and entire to pinnately lobed. Stem leaves are unstalked and clasp the stem with ear like lobes, lance to oblong shaped and smooth to deeply saw-toothed margins.

Flowers: The inflorescence head is a many flowered raceme with small white terminal flowers clusters and slender, spreading flower stalks, 7-15 mm long. Flowers are up to 8 mm across and are composed of 4 green petals with a distinctive starlike base, 1.5-4 mm long and 4 sepals, 2 mm long.

Fruits: The seeds are called silicles, which are characteristically flattened heart shaped to triangular pods, 4-8 mm long and 3-5 mm wide with minute veins. Each pod contains roughly 20 seeds. The fruit stem elongates as the fruits mature.

Habitat: Disturbed areas, such as roadsides, waste places, fields, lawns, gardens and pastures.

Distribution: Within Canada shepherd's purse is known from all provinces and territories.

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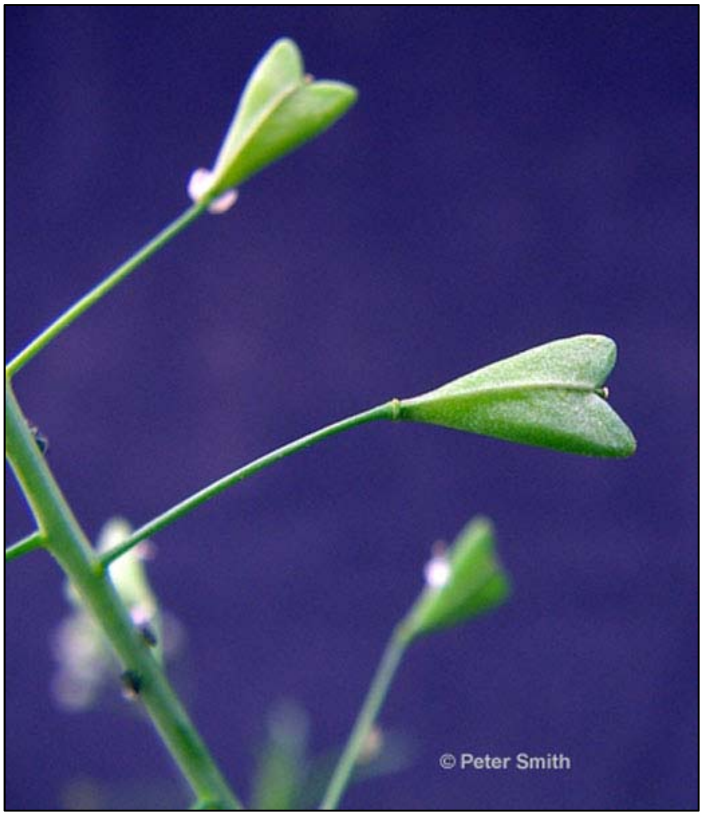

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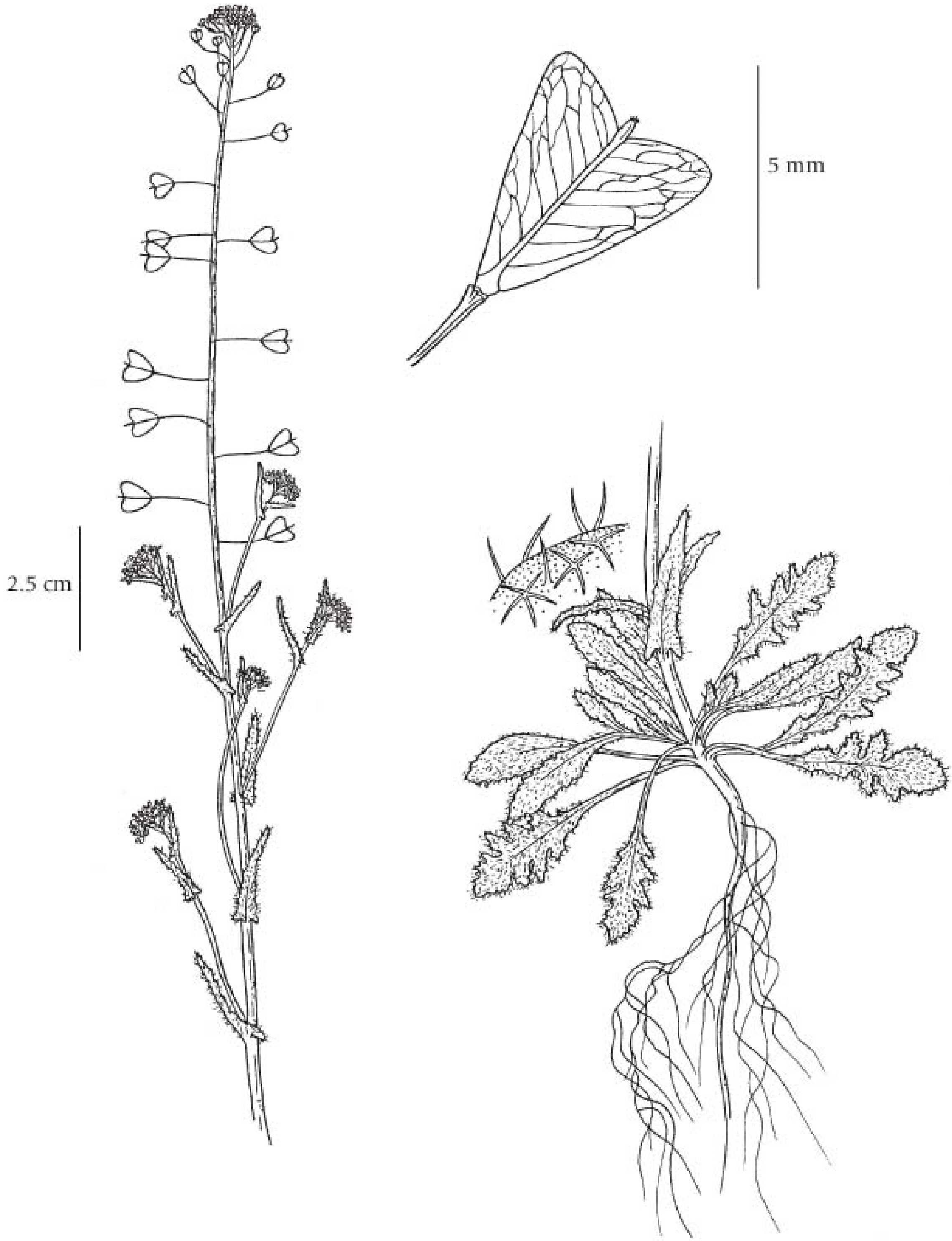

Capsella bursa-pastoris

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Yellow Rocket
Barbarea vulgaris

General: A biennial herb belonging to the Mustard Family (Brassicaceae) that was originally introduced to Canada from Eurasia. Yellow rocket forms from a taproot producing erect simple stems that are angled and branched, ranging in size from 20-80 cm tall.

Leaves: Leaves are alternately arranged on the stem. Both basal and stem leaves are present. Basal leaves are pinnatifid, long stalked with 1-2 pairs of lateral lobes and the terminal lobe being the largest, egg shaped, entire to irregularly toothed margins, 4-15 cm long. Stem leaves are similar but smaller in size and are unstalked with clasping leaf bases to the stem.

Flowers: Flowers are arranged in terminal racemes at the top of stems or reduced racemes in lower leaf axils. Flower petals are yellow, spoon to oblanceolate shaped 6-8 mm long, while sepals are pale yellow-green, about 2 mm long.

Fruits: The seeds are called siliques and they are relatively straight, elongated and upright pods, about 1-3 cm long with a distinctive beak at the top. The pod contains oblong seeds 1-1.5 mm long.

Habitat: Moist to wet disturbed areas, such as roadsides, waste places and fields.

Distribution: Within Canada yellow rocket is known from all provinces and territories.

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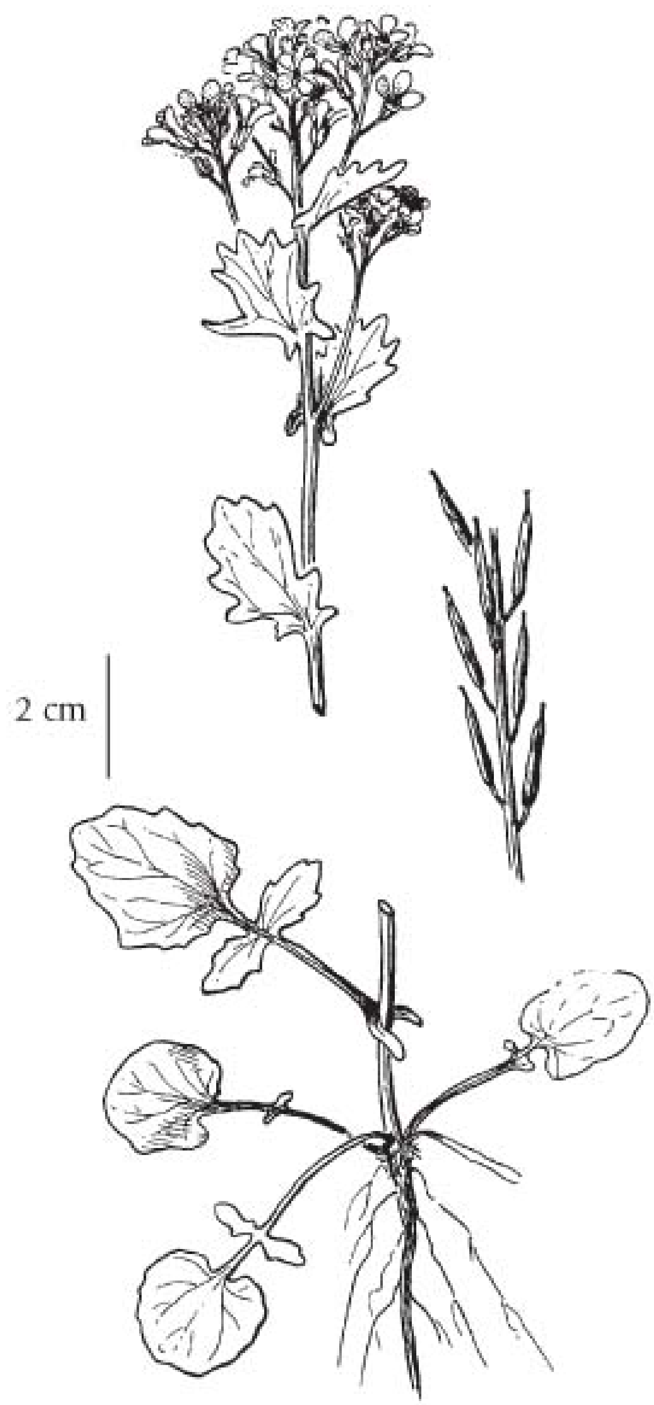

Barbarea vulgaris

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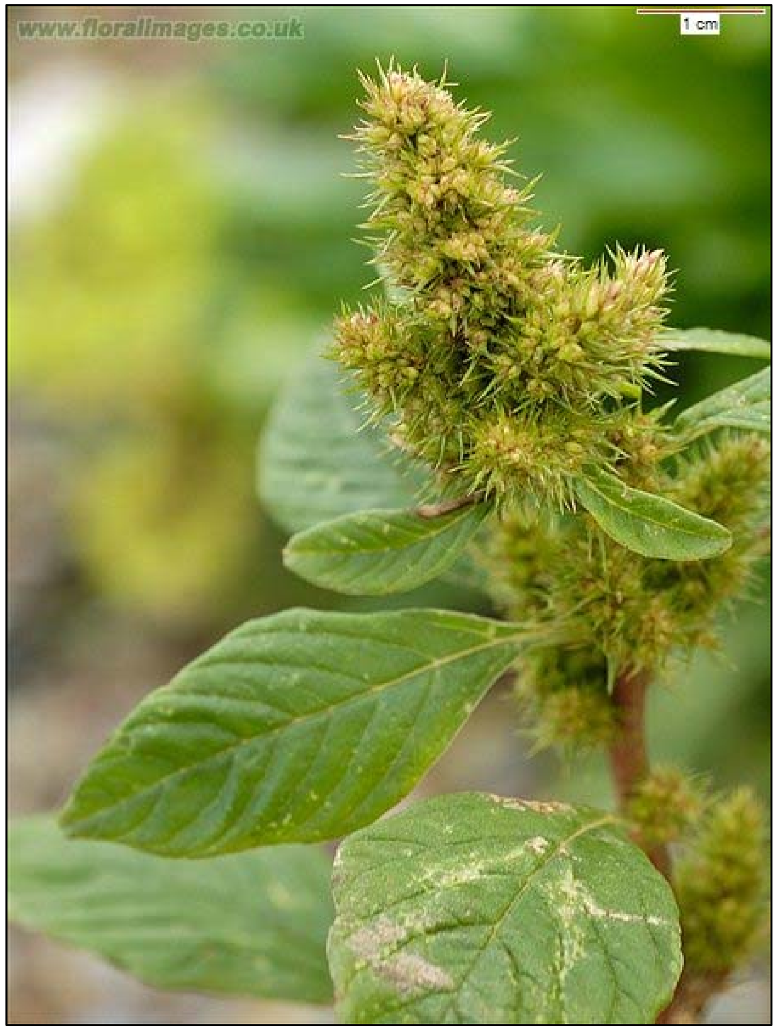
Redroot Amaranth
Amaranthus retroflexus

General: An annual herb belonging to the Amaranth Family (Amaranthaceae) introduced to Canada from the southern United States, first observed in eastern Canada around 1900, spreading to British Columbia by 1942. Redroot amaranth forms from a pinkish red, short and fleshy taproot. It is simple branched with a green or reddish stem and ranges in size from 50-100 cm tall. Redroot amaranth is <u>conspicuously hairy on the stem and leaves</u>, unless it is young or under poor growing conditions.



Leaves: Leaves are alternately arranged, ovate to diamond shaped, 3-8 cm long, 6 cm wide, generally with white and/or hairy veins below and narrow long stalks.

Flowers: Flower heads are <u>dense spike-like clusters</u>, up to 20 cm long and found both terminally at the top of the plant and in leaf axils, called armpits. Flowers are small green spikey sepals 4-8 mm long, with 1-3 spine-tipped bracts subtending it. Male flowers have 5 protruding stamens and female flowers have 1 pistil. Petals are absent.

Fruits: The seeds are black, round and shiny capsules, 1-2 mm long.

Habitat: Disturbed areas, such as roadsides, waste places, fields and pastures.

Distribution: Within Canada redroot amaranth is known from BC, AB, SK, MB, ON, QC, NB, NS, PE, NF, NT and NU.

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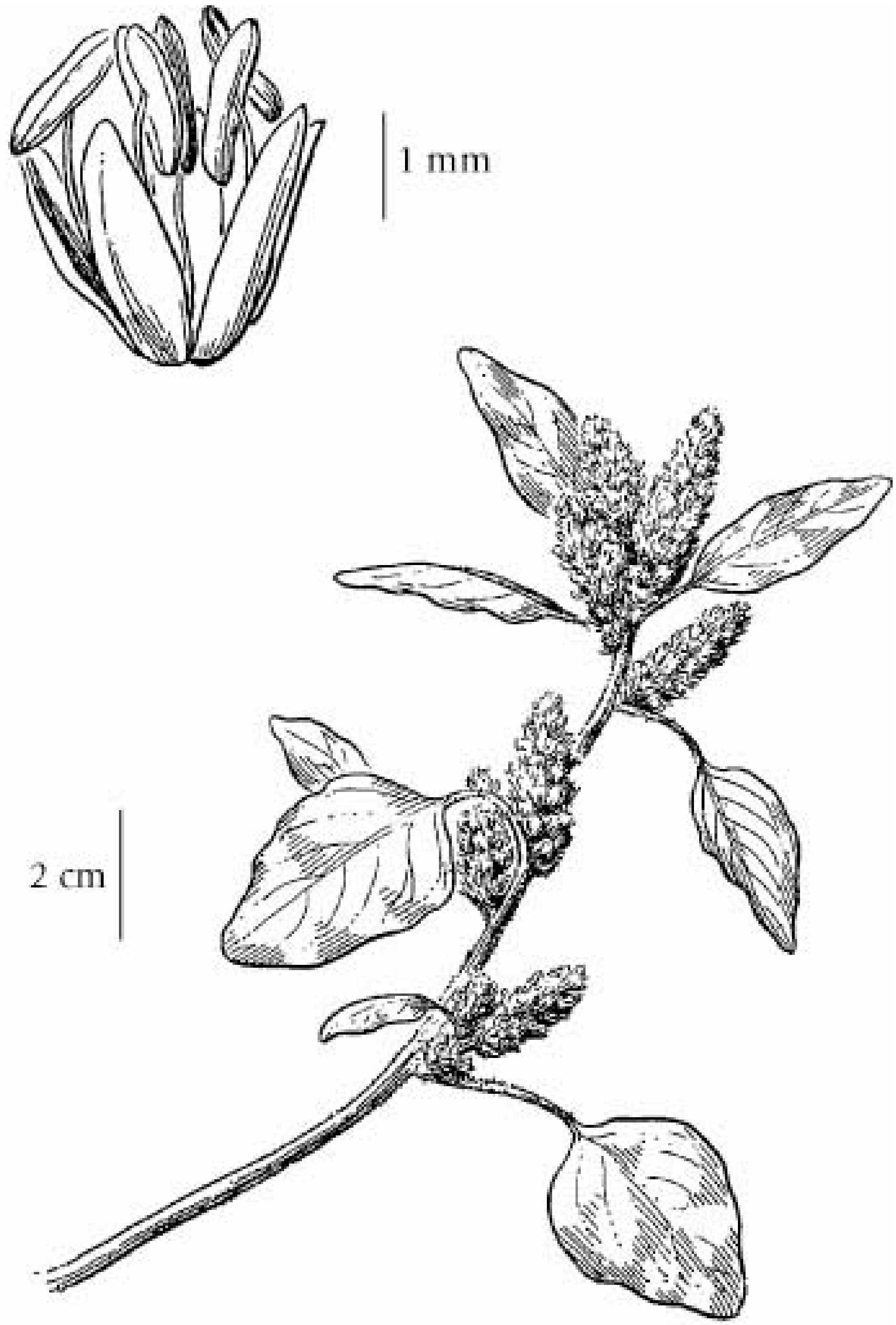

Amaranthus retroflexus

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Common Barley
Hordeum vulgare

General: An annual grass belonging to the Grass Family (Poaceae) that was originally introduced to Canada from Europe. Common barley forms from fibrous roots producing smooth, erect hollow stems, ranging in size from 80-120 cm tall. It flowers in the spring and produces fruit in the spring and summer.

Leaves: Leaf blades are mostly five along the stem (culm), 10-15 mm wide and smooth. The sheath is open at the collar which looks like a 'V' shape below where the leaf blade attaches to the culm. Also at the collar there are obvious white ear-shaped lobes, called auricles, that look like claws around the stem and a short translucent tongue-like appendage, called a ligule, about 0.5-1 mm long.

Flowers: The flowering inflorescence is a stout spike at the top of the stem with long bristles (awns), 10-15 mm long. The inflorescence itself has 3 spikelets per node, subtended by narrow glumes. The glumes are usually awned and within the glumes the lemmas are awned.

Fruits: A single seeded fruit called a caryopsis or grain is enclosed inside each lemma and palea structure.

Habitat: Disturbed areas, such as roadsides, fields and waste areas.

Distribution: Within Canada common barley is known from all provinces and territories.

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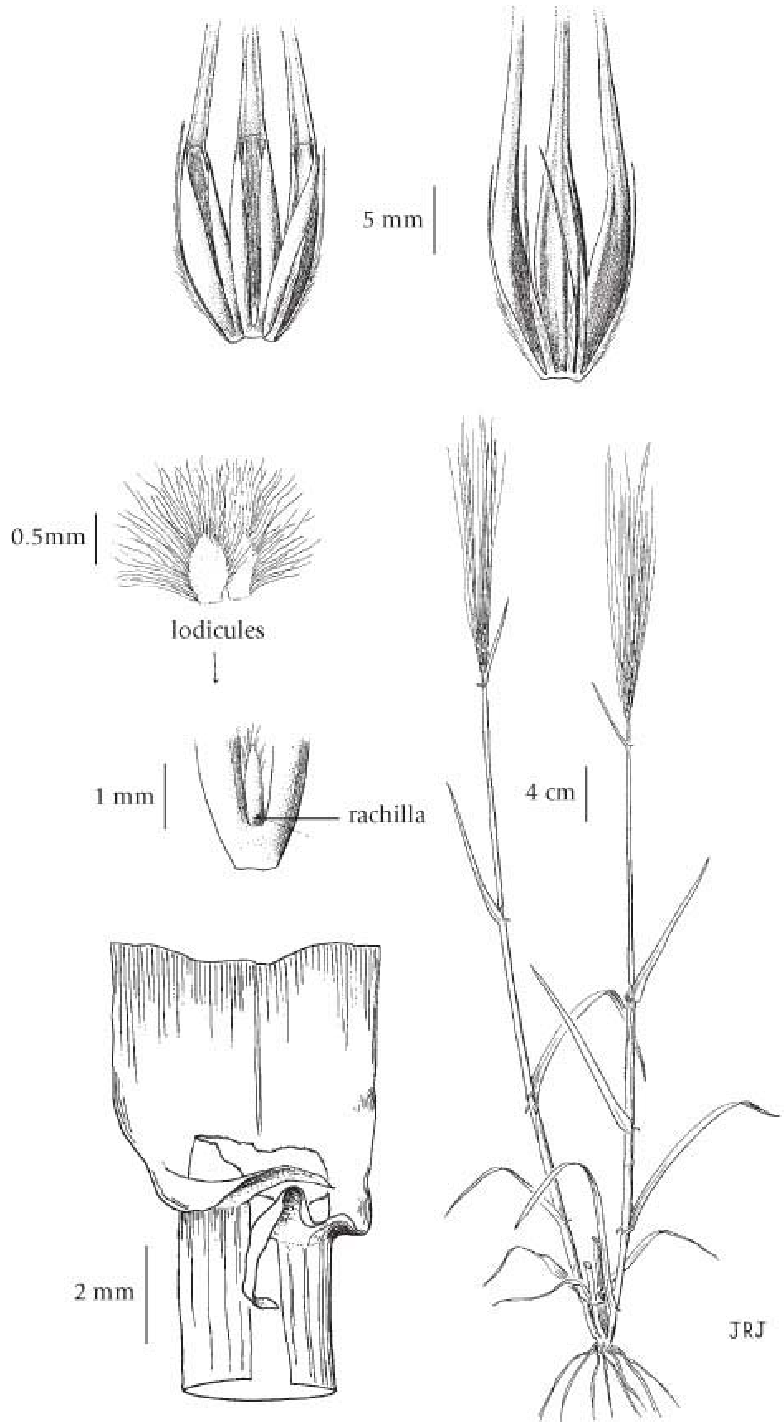

Hordeum vulgare

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Spreading Alkali Grass
Puccinellia distans

General: A perennial grass belonging to the Grass Family (Poaceae) that was originally introduced to Canada from Eurasia. Spreading alkali grass is a tufted grass that grows in a bunch and forms from fibrous roots producing smooth, erect hollow stems, ranging in size from 10-50 cm tall.

Leaves: Leaf blades are flat to slightly in-rolled, 1.5-3.5 mm long. The sheath is open at the collar which looks like a 'V' shape below where the leaf blade attaches to the stem (culm). Also at the collar there is a short translucent tongue-like appendage, called a ligule that is entire on the margin, about 1 mm long. No auricles or claw-like appendage present at the collar.

Flowers: The flowering inflorescence is an open panicle, 5-15 cm long. The branches are spreading, reflexing away from the culm and should feel rough to the touch. The inflorescence itself has 3-6 spikelets per node, subtended by egg-shaped, fine hairy glumes, ranging in size from 1-2 mm long. The glumes surround the spikelets, which are made up of a lemmas and a palea, which contain the seed. Lemmas are fringed with fine hairs at the base.

Fruits: A single seeded fruit called a caryopsis or grain is enclosed inside each lemma and palea structure.

Habitat: <u>Saline or alkaline flats, lakeshores and coastal areas</u>, as well as disturbed areas.

Distribution: Within Canada spreading alkali grass is known from all provinces and territories.

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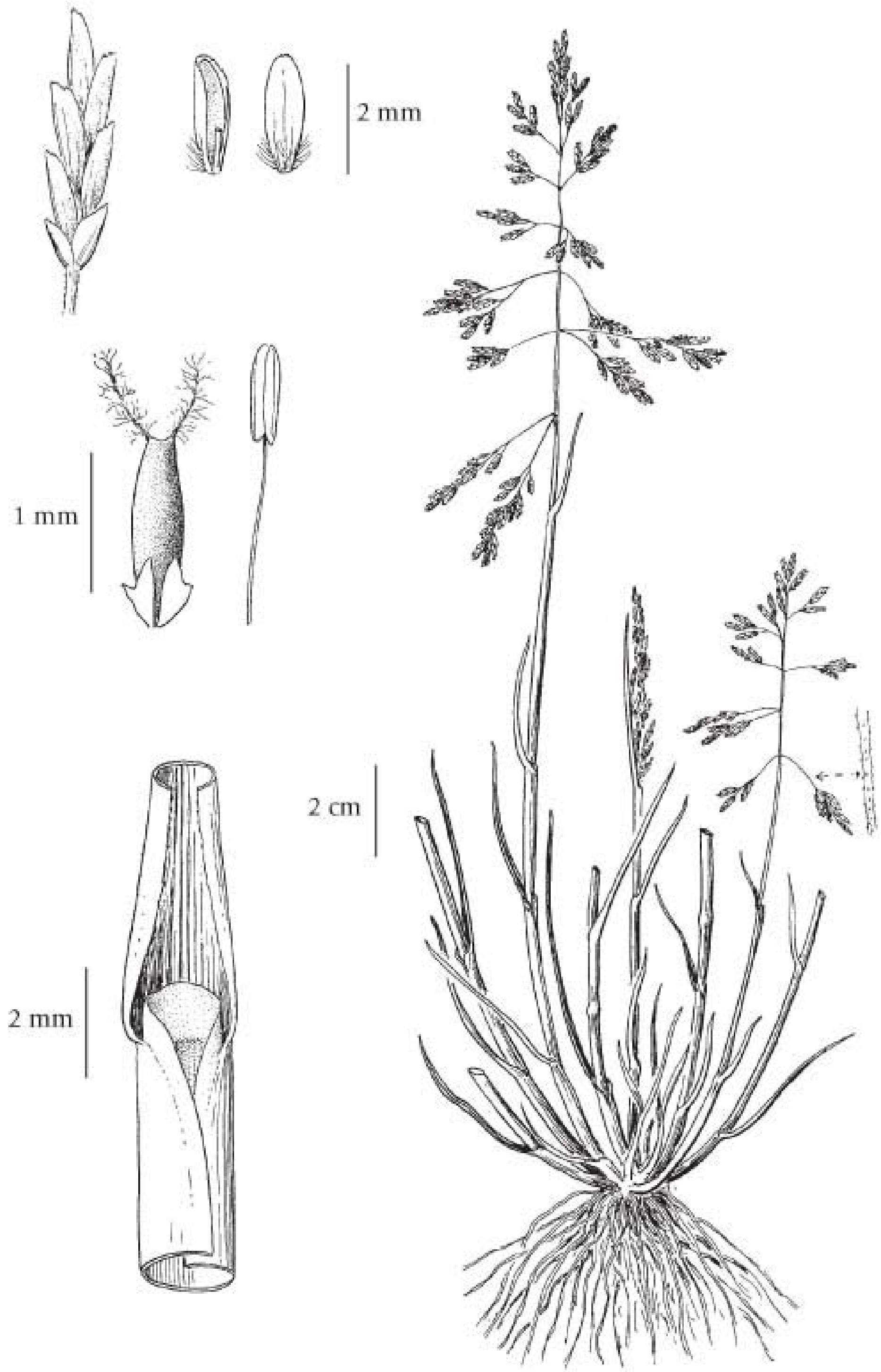

Puccinellia distans

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Tufted Vetch
Vicia cracca

General: A perennial herb belonging to the Pea Family (Fabaceae) that was originally introduced to Canada from Eurasia. Tufted vetch has climbing or trailing stems, up to 2 m long, angled to slightly grooved with short hairs, sometimes smooth.

Leaves: Leaves are alternate on the stem and pinnately compound with 12-24 linear to lance shaped leaflets, about 1-3 cm long, which narrow at the tip to a point. There are curly tendrils present at the ends of leaf braches. Where leaf branches meet the stem there are small leafy structures called stipules that are entire to toothed on the margins, 7-15 mm long.

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Flowers: Flowering heads are long stalked, found in leaf axils (armpits) where leaf branches attach to the stem, arranged as one-sided racemes of 20-70 blue to red-purple dropping pea like flowers, 8-15 mm long. Petals have an upper and lower part, not symmetrical. Sepals are half the length of the petals.

Fruits: Smooth pods, 1.5-3 cm long and contain 4-8 round, brown seeds.

Habitat: Fields, clearings, roadsides and open forest edges.

Distribution: Within Canada tufted vetch is known from all provinces and territories.

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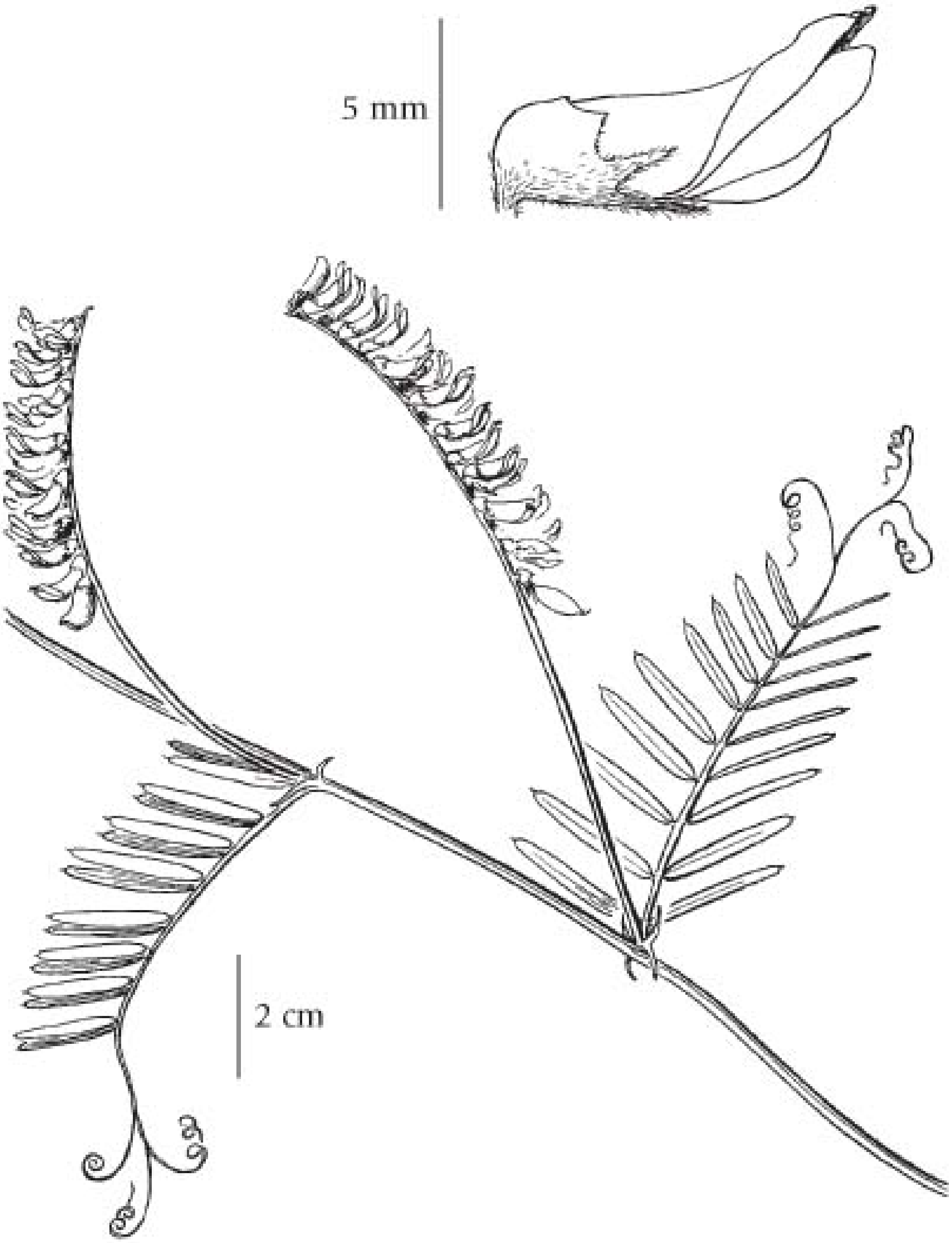

Vicia cracca ssp. cracca

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Opium Poppy
Papaver somniferum

General: An annual herb belonging to the Poppy Family (Papaveraceae) that was originally introduced to Canada from Eurasia (southeastern Europe, western Asia). Opium poppy is a widely grown garden and food plant that is said to have naturalized in areas of Canada: BC, SK, MB, ON, QC, NB, NS, NF. This species is also described as alien, agricultural weed, environmental weed, and noxious weed. It forms from a taproot producing erect, simple to branching, grey-green stems, ranging in size from 30-100 cm tall.

Leaves: Basal and stem leaves present, although basal leaves are few and soon deciduous. Stem leaves are alternate, unstalked, oblanceolate in outline with shallow lobes and toothed to wavy margins, 5-30 cm long. Leaf bases are heart shaped and clasp the stem.

Flowers: Flowers are erect, solitary and terminal at the top of the stem, 4 white-purple or rose petals, about 2-6 cm long with a pale to dark spot at the base of the petals. Flower stalks are hairy. When in bud the unopened flowers are nodding.

Fruits: Terminal, round, smooth, grey-green to blue-white capsules, 2.5-5 cm long with a flat brown cap on top.

Habitat: Disturbed areas, such as roadsides, waste places, gardens and pastures.

Distribution: Within Canada opium poppy is known BC, AB, SK, MB, ON, QC, NB, NS, NF and NU.

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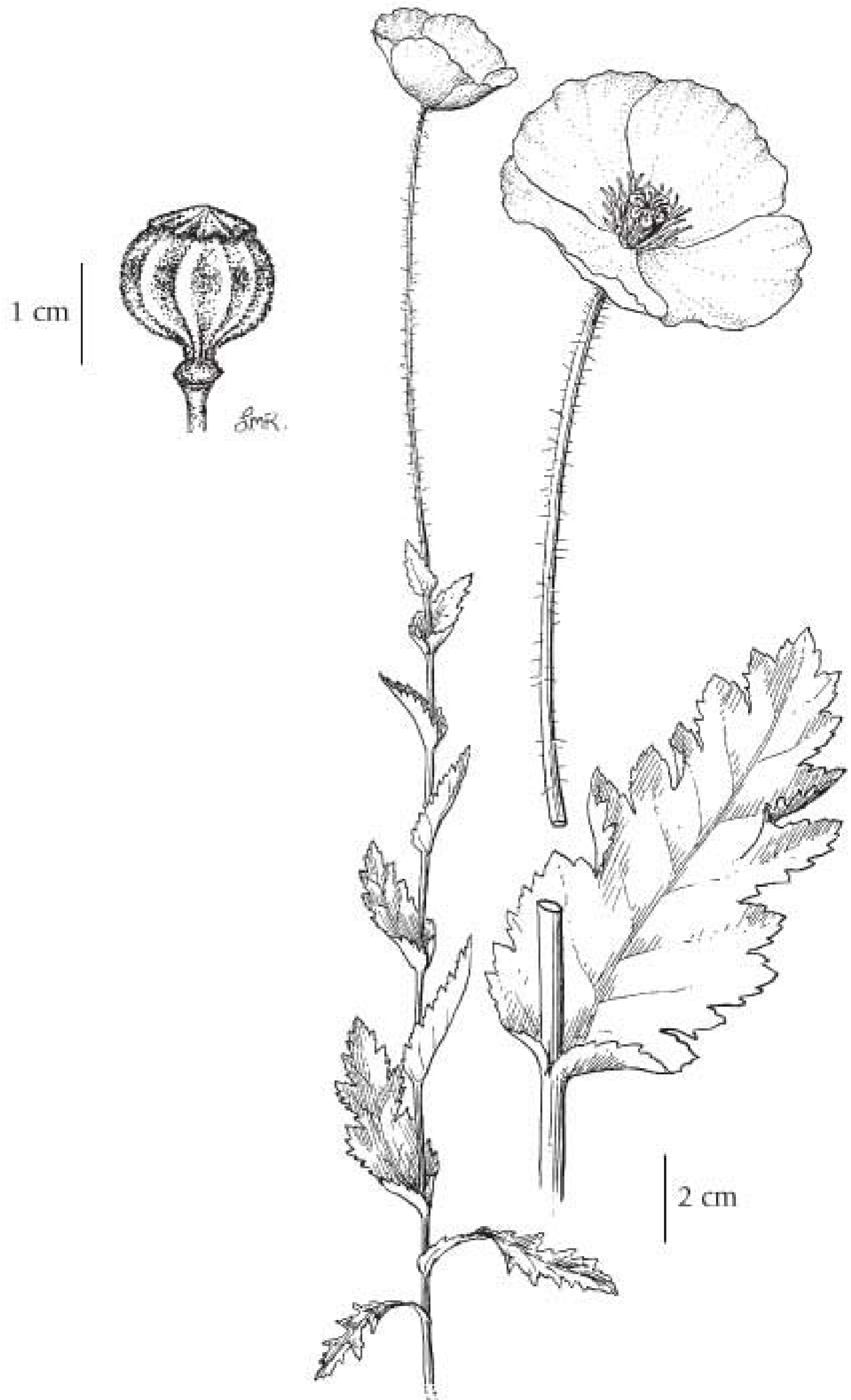

Papaver somniferum

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Common Plantain
Plantago major

General: A perennial herb (sometimes annual or biennial) belonging to the Plantain Family (Plantaginaceae) that is believed to have native populations in Canada (YT, ON), as well as introductions from Eurasia. Depending on the source, this plant can be weedy or invasive. Common plantain is a shade-intolerant species that forms from fibrous roots producing several erect, simple, smooth to hairy stems ranging in size from 5-50 cm tall.

Leaves: All leaves are basal, long stalked, broadly elliptic to lance shaped, mostly entire on the margin, but sometimes irregularly toothed, 4-18 cm long and 2.5-11 cm wide. Leaves are strongly parallel veined.

Flowers: Flower heads are terminal, dense, narrow spikes, 5-30 cm long at the top of a leafless stem. Flowers are green-white. Both petals and sepals are 4 lobed and 4 stamens stick out of the flower. One style is present per flower.

Fruits: Round capsule, 2-4 mm long, which contains 5-30 black-brown, finely veined seeds about 1 mm long.

Habitat: Disturbed areas, such as roadsides, waste places, gardens, lawns, fields and pastures.

Distribution: Within Canada common plantain is known from all provinces and territories.

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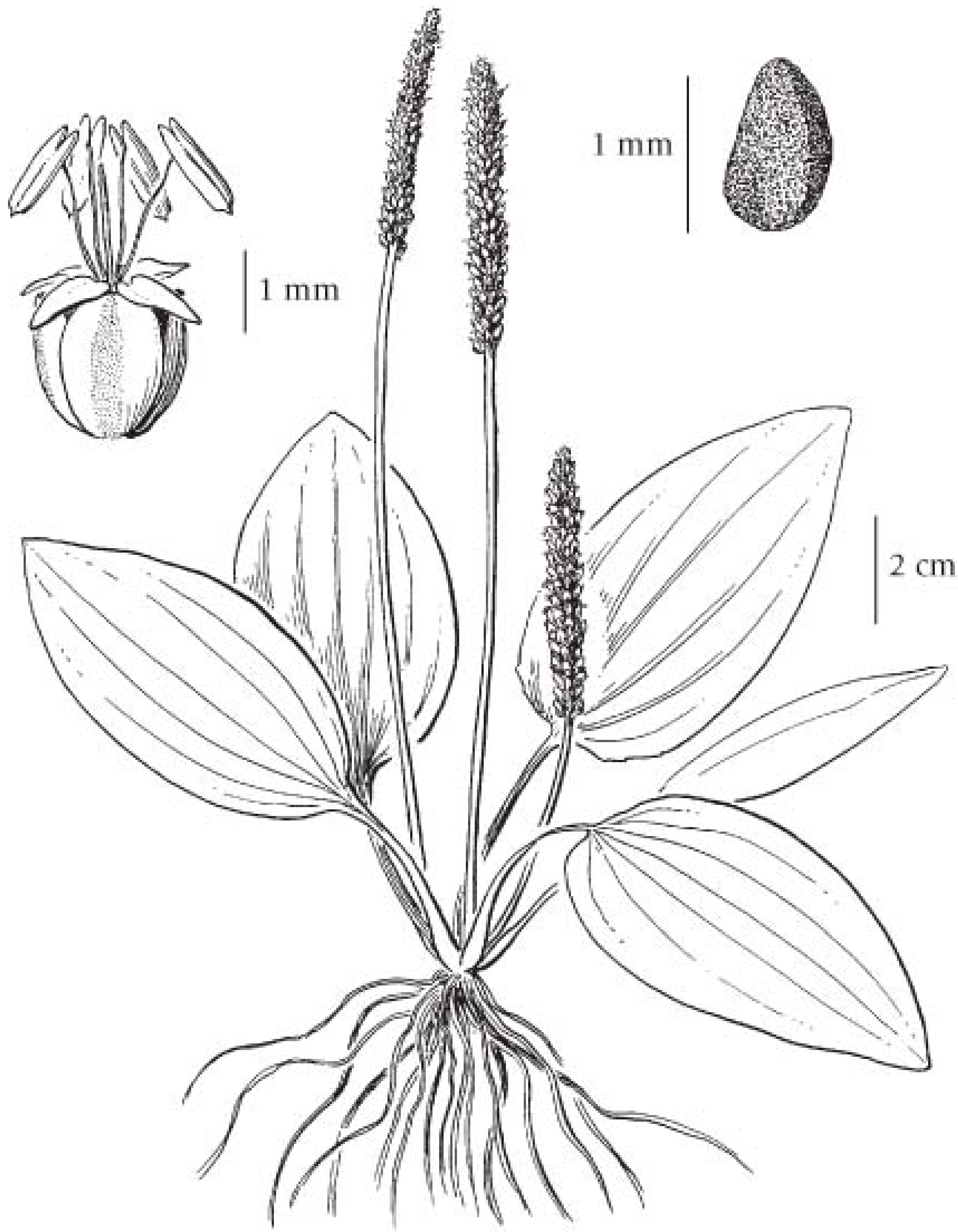

Plantago major

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Prostrate Knotweed
Polygonum aviculare

General: An annual herb belonging to the Buckwheat Family (Polygonaceae) that was originally introduced to Canada from Eurasia. Prostrate knotweed forms from a wiry taproot producing several, erect to prostrate, ridged and branching stems that range in size from 10-100 cm tall.

Leaves: Basal leaves lacking. Stem leaves are alternately arranged on the stem, linear to lance-oblong in shape with an overall blue-green hue, 1-3 cm long. Leaves are found along the stem and branches. This species has characteristic sheathing, brown stipules where the stem and branches join, 3-6 mm long and ragged on the margins.

Flowers: Flower inflorescences are found in leaf axils (armpits), made up of small clusters of 1-5 greenish sepals with white to pink edges. Petals are absent.

Fruits: A single seeded fruit, called an achene is dark brown, 3-angeled with linear lines and pimples, 2.8-3.5 mm long.

Habitat: Disturbed areas, such as roadsides and waste places.

Distribution: Within Canada prostrate knotweed is known from all provinces and territories.

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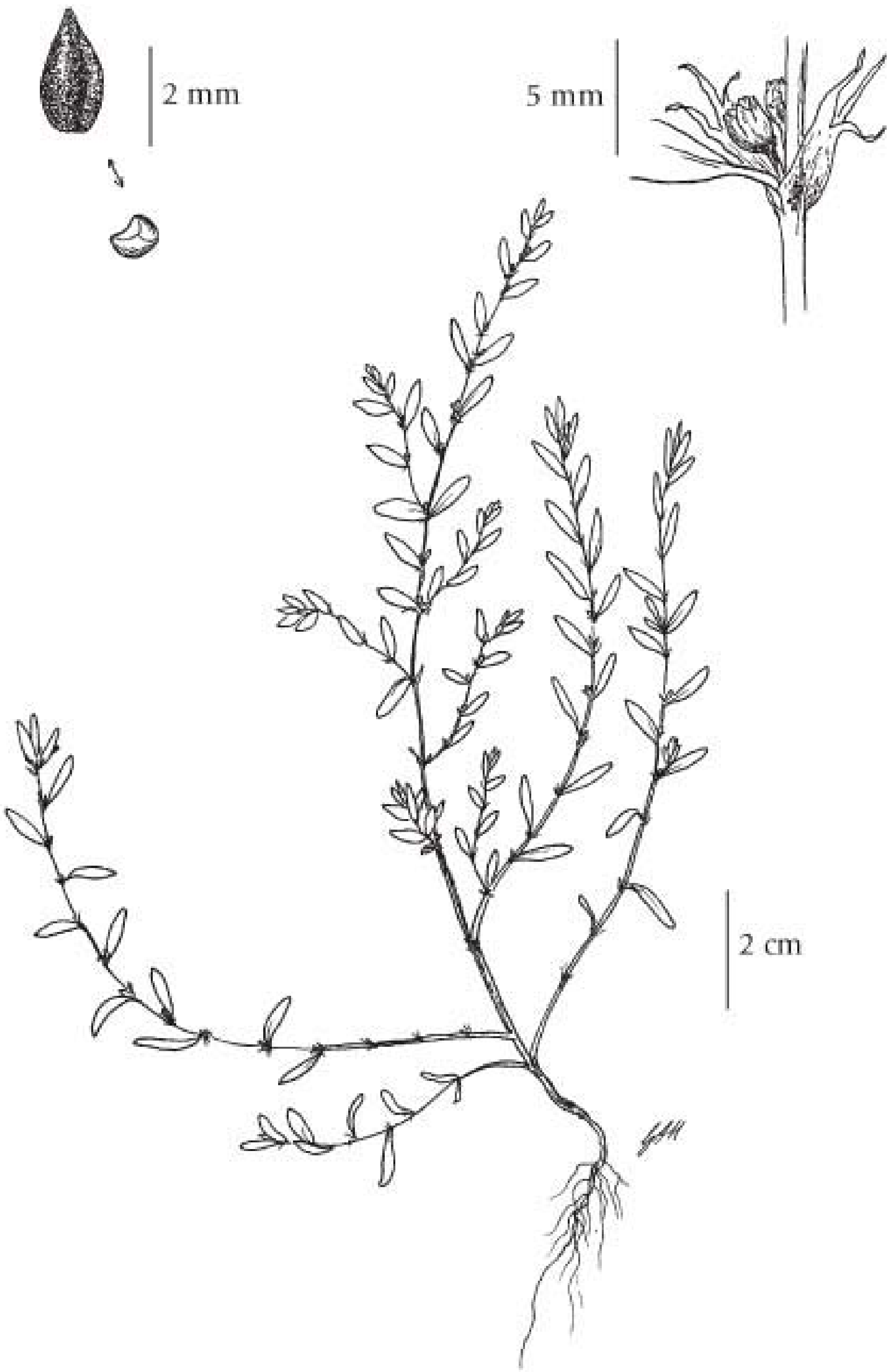

Polygonum aviculare

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